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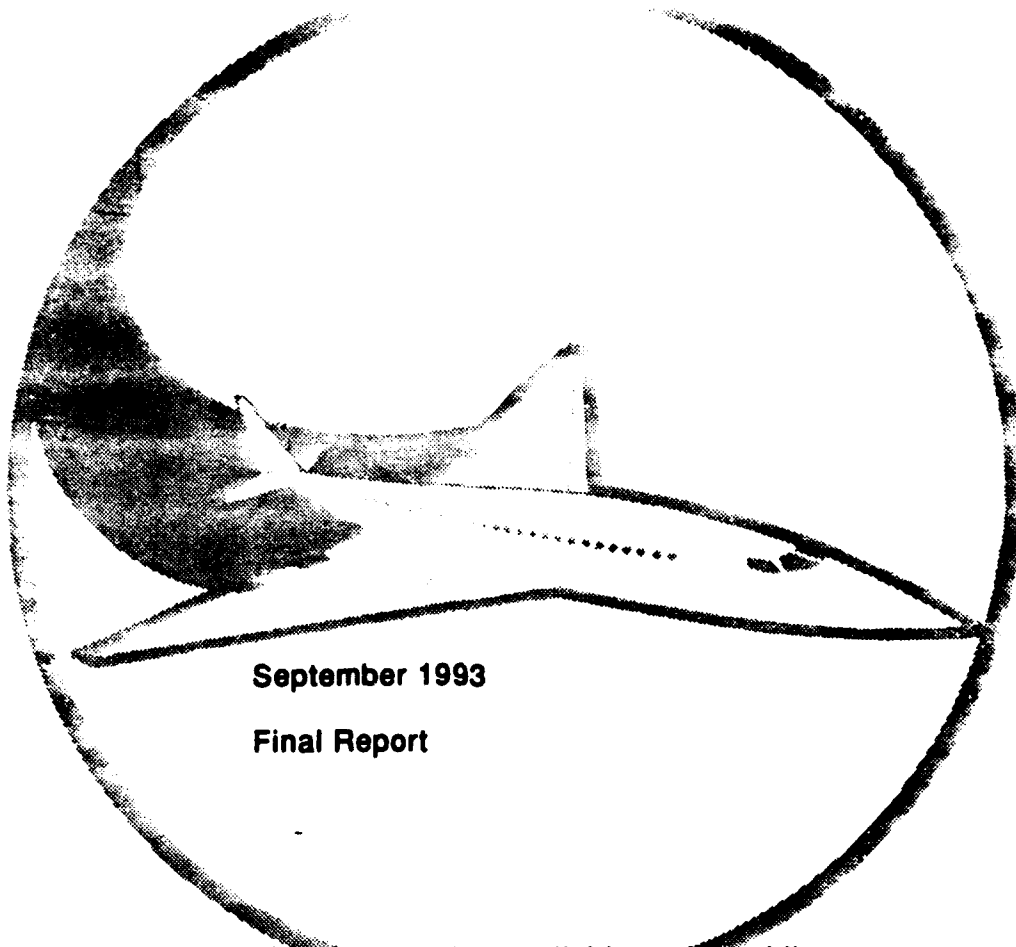


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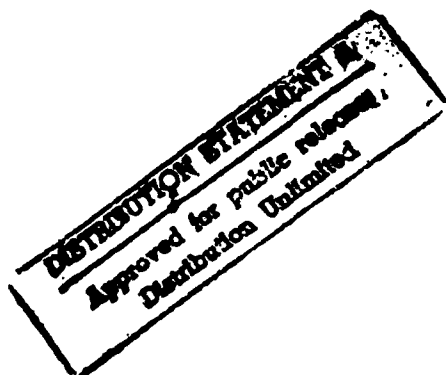
Aircraft Turbine Engine Reliability and Inspection Investigations



September 1993

Final Report

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16. Abstract This study of JT9D, CF6, and PT6 aircraft engine reliability represents a follow-on effort to the JT8D engine study which was published in the Federal Aviation Administration (FAA) Technical Center Final Report DOT/FAA/CT-91/10. As with the JT8D engine study, this study trended in-flight shutdowns and unscheduled removal rates of JT9D, CF6, and PT6 turbine aircraft engines for a thirty-six-month period covering February 1988 through January 1991. As in the previous report the methodology was to review which air carriers consistently exceeded the standard deviation norm for in-flight shutdowns and unscheduled engine removals on a monthly basis and then examine the engine component failures reported by those carriers. Engine component failures were grouped as follows: bearings, airfoils, cases, controls and accessories, fuel/oil systems, and others (not trended). For this study of the JT9D, CF6, and PT6 engines, controls and accessories typically produced the largest number of in-flight flameouts, compressor stalls, and engine shutdowns. In addition to the actuarial analysis and component failure mode trending performed on the JT9D, CF6, and PT6 engines, application of an inspection procedure developed for the JT8D engine was made on the JT9D and CF6 engine cases.					
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PREFACE

This report was prepared by Science Applications International Corporation (SAIC) under contract number 67-6733 with Sandia National Laboratories, Albuquerque, New Mexico, for the Federal Aviation Administration (FAA) Technical Center. The FAA has established an Aging Aircraft Nondestructive Inspection (NDI) Development and Demonstration Center (AANC) at Albuquerque International Airport and Sandia National Laboratories. This work supports the AANC and the FAA's National Aging Aircraft Research Program.

The JT9D, CF6, and PT6 engine trending and component analysis was conducted by the SAIC Logistics Technology Division located in San Antonio, Texas. A. Bruce Richter and Margaret Ridenour-Bender performed the actuarial data analysis. The development of the NDI technique for the JT9D engine diffuser, the CF6 turbine mid-frame and compressor rear frame cases was accomplished by the SAIC Ultra Image International Division located in New London, Connecticut, under the direction of Robert H. Grills and Mike C. Tsao.

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ABBREVIATIONS

ACAUPRR	Air Carrier Aircraft Utilization and Propulsion Reliability Reports
CRF	Compressor Rear Frame
DS	Directionally Solidified
EC	Eddy Current
EDM	Electrode Discharge Machine
EGT	Exhaust Gas Temperature
EVC	Engine Vane Controller
FAA	Federal Aviation Administration
FOD	Foreign Object Damage
GE	General Electric
NDI	Nondestructive Inspection
NG	Gas Generator
PRBC	Pressure Ratio Bleed Control
PWA	Pratt & Whitney Aircraft
SAIC	Science Applications International Corporation
SDR	Service Difficulty Reports
TIG	Tungsten Inert Gas
TMF	Turbine Mid-Frame
UI-IV™	Ultra Image IV™

EXECUTIVE SUMMARY

This study of JT9D, CF6, and PT6 aircraft engine reliability represents a follow-on effort to one which initially focused on the JT8D engine. The results of the JT8D engine study were published in the FAA Technical Center final report DOT/FAA/CT-91/10.

The actuarial analysis approach used in the JT8D engine study had been to trend in-flight shutdowns and unscheduled engine removals over a twenty-four month period. The same approach has been used in this study of JT9D, CF6, and PT6 engines, using a thirty-six month period covering February 1988 through January 1991. The methodology, as in the previous report, was to review which air carriers consistently exceeded the standard deviation norm on a monthly basis and then to examine the component failures reported by those air carriers. Only FAA data has been used in this report. Conversations with the engine manufacturers and selected air carriers were used to confirm trends exhibited by the analysis of the FAA data.

Two JT8D engine components identified in the initial study for possible development of NDI procedures were the #6 bearing oil tube and the 13th stage bleed air duct. It was determined that NDI procedure development was inappropriate for each of these items since recent modifications had resolved the documented problems.

Each of the three engines (JT9D, CF6, and PT6) has been reviewed for component failure trends. The original tasking was to review engine component failure information from 1983 through 1991. However, the FAA central data bank containing Service Difficulty Report (SDR) information could only provide data from January 1986 through November 1991. Major engine component areas reviewed have included: bearings, airfoils, cases, controls and accessories, and fuel/oil systems. These engines represent different design types (turbofan versus turboprop), improved component designs (air cooled turbine air foils), and materials technology so direct comparisons should be avoided. However, the percent of failure incidents is shown below for each engine type including the JT8D engine:

<u>ORIGIN OF FAILURE</u>	<u>JT8D</u>	<u>CF6</u>	<u>JT9D</u>	<u>PT6</u>
BEARINGS	12%	5%	4%	7%
AIRFOILS	26%	26%	10%	7%
CASES	2%	3%	2%	----
CONTROLS & ACCESSORIES	23%	39%	44%	55%
FUEL/OIL SYSTEMS	20%	11%	10%	15%
OTHERS (NOT TRENDED)	17%	16%	30%	16%

For this study of the CF6, JT9D, and PT6 engines, controls and accessories typically produced the largest number of in-flight flameouts, compressor stalls, and engine shutdowns. Diagnostic troubleshooting procedures for controls and accessories for these engines have not been effective as multiple accessories are removed for precautionary measures to resolve in-flight flameouts. This practice drives high spares inventories and increases backshop repair costs for units retesting "okay".

Other major observations from the analysis of this failure data include:

1. Although bearing material and design technology has improved, main bearings continue to be a reliability problem.
2. Airfoil component reliability has significantly improved with the use of air cooling technology and Directionally Solidified (DS) material, but airfoils suffer because these materials are damaged during compressor stalls when cooling air flows are disrupted.
3. Fuel/oil system failures are highly susceptible to maintenance errors such as unsecured oil caps, pinched seals, stripped mounting studs, and gaskets/shims left out.

Reviews with Pratt & Whitney Aircraft (PWA) personnel on the JT9D engine and General Electric (GE) Aircraft Engine personnel on the CF6 engine validated the component failure trending accomplished. Several engine component failure trends already had configuration upgrades defined and implemented, while others were under study or not yet addressed by the engine manufacturer. A listing of the components identified during the SDR failure trending, by engine, follows:

JT9D ENGINE COMPONENT FAILURE TRENDS

#3 BEARING
8TH STAGE COMPRESSOR BLADE
1ST STAGE TURBINE BLADE
FUEL PUMP SHAFT
ENGINE VANE CONTROLLER
FUEL PUMP/FUEL CONTROL
DIFFUSER CASE

CF6 ENGINE COMPONENT FAILURE TRENDS

1ST STAGE TURBINE BLADES
COMPRESSOR REAR FRAME CASE
TURBINE MID-FRAME CASE
FUEL CONTROL/FUEL PUMP
INLET GEARBOX

PT6 ENGINE COMPONENT FAILURE TRENDS

FUEL CONTROL
BLEED VALVE
FUEL PUMP

In addition to the actuarial analysis and component failure mode trending performed on the JT9D, CF6, and PT6 engines, application of an inspection procedure developed for the JT8D engine was made on JT9D and CF6 engine cases. The ultrasonic inspection procedure developed for JT8D engine outer combustor case drain bosses has applicability to other engine cases. This study applied that technology to inspection of manufacturing and repair welds on JT9D engine diffuser cases, CF6 engine turbine mid-frame cases, and CF6 engine compressor rear frame cases. The focus of the inspection work was to be able to detect small flaws in both manufacturing and repair welds and the adjacent heat affected zones. The larger grain size of these welds typically distorts ultrasonic inspection signals searching for flaws within the weld material. This same phenomenon also occurs when cast material is used in engine cases, as in the CF6-6/-50 engine compressor rear frame cases. This study successfully demonstrated the ability to penetrate weld material and detect flaws of 0.020 inch in length.

A permanent record of the inspection findings is a very necessary part of component life management. Recording compliance of a required inspection is not as effective as documenting the exact inspection results. The ultrasonic inspection procedure used in this study produced permanent records of the inspections made.

INTRODUCTION

PURPOSE

This study is a follow on effort to the Turbine Aircraft Engine Operational Trending and JT8D Static Component Reliability Study (Report DOT/FAA/CT-91/10) dated March 1992. In this study an actuarial trending analysis was conducted to review the operational reliability of the JT8D, CF6, and JT3D engines, and to also develop an NDI procedure for the JT8D engine outer combustor case. The actuarial analysis consisted of trending in-flight shutdowns and unscheduled engine removal rates of JT8D, CF6, and JT3D turbine aircraft engines for the two-year period from February 1988 to January 1990. These data are currently collected each month by the FAA and published in the Air Carrier Aircraft Utilization and Propulsion Reliability Reports (ACAUPRR). Using actuarial data from these reports, the monthly industry average and standard deviation of shutdown and unscheduled removal rates were calculated for each airframe and engine combination. The industry norm was then calculated as one standard deviation above the industry average. Rate data from individual U.S. operators of those engines were then compared to the monthly industry norm and the results were trended to determine which operators were experiencing higher than industry normal values for engine shutdown and unscheduled removal rates. Once the operators were identified, the FAA's SDR data base was queried for each of those operators to determine which components may have caused the higher than normal engine shutdowns and unscheduled engine removal rates. Actuarial trending was completed on JT8D, CF6, and JT3D engines, however, component failure analysis was completed only for the JT8D. The following JT8D components and conditions were discovered and reported in DOT/FAA/CT-91/10:

Hard Failures

- #3 Bearing
- #4.5 to #6 Oil Bearing Tube

Diagnostic Troubleshooting

- Fuel Controls, Fuel Pumps

Wear and Tear/Inspection Failures

- 13th Stage Bleed Air Duct
- Turbine Blades

Maintenance Practices

- Oil Cap Unsecured
- Fuel/Oil Heater Valve Wired Open
- Oil Screen Studs Pulled Loose
- Oil Seals Pinched

Structural Failures

- Case Cracking

The #6 bearing oil tube and the 13th stage bleed air duct had been identified in the initial study as possibly requiring enhanced NDI procedures. This study reviewed the status of those items and determined recent modifications had resolved the documented reliability problems. Both modifications are being incorporated by the air carriers.

The purpose of this study was to conduct an actuarial trending and component analysis to review the operational reliability of the JT9D, CF6, and PT6 engines. In addition, the NDI procedure for the JT8D engine outer combustor case developed under the Turbine Aircraft Engine Operational Trending and JT8D Static Component Reliability Study was applied to the JT9D engine diffuser case and the CF6 engine turbine mid-frame (TMF) and compressor rear frame (CRF) cases. Close coordination with the original engine manufacturers, PWA and GE, was maintained. Observations derived from the actuarial analysis and the NDI procedures were briefed to and accepted by the original engine manufacturer.

Observations, conclusions, and recommendations on specific airline operational performance and maintenance practices were not part of the purpose of this task. In that regard, no identities of specific airline performance and their respective component failures have been made.

Although the original tasking required a component review for the period 1983 through 1991, the FAA data bank only contained data that was reported from January 1986 through the requested date of information output, which was November 1991. Some component failure incidents occurred in 1985 but were not reported to the FAA data bank until 1986; therefore only partial data for 1985 is included in this study.

BACKGROUND

The aerospace industry's attention toward aging aircraft has generally been focused upon aircraft fuselage structures. The philosophy towards aircraft engines has historically been that engines were periodically "regenerated" through scheduled maintenance and modification programs. For many of the dynamic components, like blades, disks, and spacers, this is basically true and applies equally to some static parts such as vanes and combustors. However, other static parts such as fan, compressor,

diffuser, turbine and exhaust cases are not life limited and therefore not subject to periodic replacement. The engine subpanel of the June 1988 International Conference on Aging Airplanes and subsequent conferences identified the need for improved NDI procedures for aircraft turbine engine cases and frames. The Turbine Aircraft Engine Operational Trending and JT8D Static Component Reliability Study outlines an ultrasonic NDI procedure for the JT8D engine outer combustor case. A failure analysis using data from the SDR data bank was completed on the JT9D and CF6 engine cases to determine if a failure pattern was evident that would benefit from the development of an NDI procedure. In addition, the original engine manufacturers and air carriers were contacted to identify which areas of the engine required enhanced inspection procedures. The analysis identified the JT9D engine diffuser case, the CF6 TMF and the CF6 CRF. Using the JT8D engine outer combustor case NDI procedure as a foundation, preliminary ultrasonic NDI procedures were developed for the JT9D engine diffuser case. An analysis was conducted to determine the applicability of using an ultrasonic inspection to detect cracks in the CF6 TMF and CRF.

In general, the original engine manufacturers are quick to respond to any immediate inspection procedure requirement especially when safety of flight is involved. This study investigated the practicability of applying the ultrasonic inspection procedure developed for the JT8D engine outer combustor case on either cases or frames for the JT9D or CF6 engines. Application of successful NDI procedures from one type of engine to another is not a common practice. As such, development of a successful cross application procedure could provide substantial economic benefits for the airlines.

PROCEDURE

DATA SOURCES

This study included an analysis of the JT9D, CF6, and PT6 engine inventories to determine which air carriers reported higher than normal engine in-flight shutdowns and engine removal rates. The objective of the data analysis was to identify those engine components recorded as causing the high rates of in-flight shutdowns and engine removals. The following sources of information were used for this actuarial study:

1. The FAA ACAUPRR, as published on a monthly basis by the Aviation Standards National Field Office at Oklahoma City, Oklahoma. This report provides the following monthly information by aircraft, engine type, and air carrier:
 - Number of aircraft by aircraft model and engine series
 - Engine shutdowns & shutdowns/1000 hours
 - Engine removal & removals/1000 hours for premature unscheduled removals
 - 3-month moving average of engine shutdowns/1000 hours
 - Engine fleet hours
2. FAA SDRs as published by the Aviation Standards National Field Office with each issue covering a one week period. The engine section of this report provides:
 - Information on specific engine incidents, identifying the air carriers involved, aircraft models, aircraft serial number, description of the problem and often the investigation results and corrective actions taken.
3. Printouts from the FAA Operational Systems Branch, AVN-120 on the JT9D, CF6 and PT6 engine component failures from January 1986 through November 1991 that provide:
 - Information on specific engine incidents, identifying the air carriers involved, aircraft and engine dash models, date of component failures, takeoff aborts, engine shutdowns, flights diverted, description of failures, tear down results and corrective actions taken.

TRENDING METHODOLOGY

The data analyzed in this study came from the monthly FAA ACAUPRR. For the 36-month period from February 1988 through January 1991, in-flight shutdowns and unscheduled engine removal rates were trended for all U.S. operated JT9D, CF6, and PT6 engines. From these data, monthly industry-wide average rates of in-flight shutdowns and engine removals were calculated for each of the following airframe/engine combinations:

Engine:	JT9D
Airframe:	B-747, B-767, DC-10

Engine: CF6
Airframe: A-300, B-767, DC-10

Engine: PT6
Airframe: BE-1900, BE-99, DHC-6, DHC-7, EMB-110, SH SD-330.

The actuarial analysis methodology has five steps as follows:

- Step 1: Collect in-flight shutdown and unscheduled engine removal date from the ACAUPRR.
- Step 2: Calculate the standard deviation of the in-flight shutdown and unscheduled engine removal rates by month, for specific airframe/engine combinations.
- Step 3: Develop a summary data sheet reflecting airlines' experiences with in-flight shutdowns and unscheduled engine removals.
- Step 4: Based upon the percentages calculated from the data, identify airlines to be reviewed for specific component failures.
- Step 5: Review the specific component failures identified by airline for failure causes and analysis of trends.

A complete definition of each step is included below with examples of the data products developed. It should be noted these data products have been developed from FAA data sources only and no additional input has been received from the engine manufacturers or airlines.

STEP 1: COLLECT DATA

Data is obtained from the FAA ACAUPRR. Table 1 is a sample of JT9D engine data for the month of February 1988. Data from the ACAUPRR is recorded verbatim on the data sheet and a standard deviation is calculated by airframe/engine combination. When either the aircraft model series number or the engine model series number was not specified, the FAA ACAUPRR identifies this lack of information by placing an asterisk (*) adjacent to the aircraft model or the engine model. This same identification was used on the actuarial trending throughout this report.

STEP 2: CALCULATE STANDARD DEVIATION

Line item information collected during Step 1 is used to calculate the monthly standard deviation. This calculation is based upon the number of incidents per 1000 flying hours. A separate calculation is made for in-flight shutdowns and for unscheduled engine removals. The standard deviation is calculated based on the ratio of the pooled in-flight shutdowns and pooled unscheduled engine removals to the total number of engine hours. Using the pooled rates creates a normalized standard deviation calculation. Therefore one exceptionally high entry will not artificially skew the data. The following equations were used for the standard deviation calculation:

summation of incidents, ΣI

summation of fleet engine hours, ΣH

average X (norm) per 1000 flying hours, $X = (\Sigma I / \Sigma H) * 1000$

standard deviation, $[(X / \Sigma H) * 1000]^{1/2}$

red range: average X + standard deviation

Whenever an air carrier flew more than one airframe/engine combination, a weighted average was calculated for that air carrier. Table 2 identifies the B-747 aircraft with JT9D engine monthly performance for in-flight shutdown rates per 1000 hours for the 36-month period. ND means No Data.

Table 3 identifies the B-747 aircraft with JT9D engine monthly performance for unscheduled engine removal rates per 1000 hours for the 36-month period.

TABLE 1. ACAU AND PRR DATA 2/88 (JT9D)

Aircraft	Engine	Airline	Number	Daily	Fleet	Engine Shutdowns		Engine Removals	
Model	Model		ACFT	Util Hrs	Eng Hrs	#SD	1000 HRS	#REM	1000 HRS
747*	JT9*	CTA	2	11	2636	2	0.76	0	0.00
747*	JT9*	ABC	35	11	46364	3	0.06	3	0.06
747*	JT9*	AAA	6	4	3124	0	0.00	0	0.00
747*	JT9D7	QQQ	1	11	1260	0	0.00	0	0.00
747*	JT9D70A	QQQ	1	11	1328	0	0.00	0	0.00
747*	JT9D7A	QQQ	7	9	7680	9	1.17	1	0.13
747*	JT9D7A	BKB	11	8	10156	1	0.10	3	0.30
747*	JT9D7A	DAR	4	8	3900	1	0.26	1	0.26
747*	JT9D7A	RAB	11	11	13980	1	0.07	1	0.07
747*	JT9D7AH	LWZ	18	10	20844	1	0.05	2	0.10
747*	JT9D7F	BKB	9	8	8504	0	0.00	3	0.35
747*	JT9D7R4G2	RAB	2	11	2640	0	0.00	0	0.00
747122	JT9D3A	RAB	13	12	17536	0	0.00	3	0.17
747133	JT9D7A	QQQ	1	7	808	1	1.24	1	1.24
747200B	JT9*	CTA	6	8	5616	4	0.71	1	0.18
747245F	JT9D70A	QQQ	4	11	5240	0	0.00	1	0.19
747245F	JT9D7Q	QQQ	2	7	1600	0	0.00	1	0.63
747249F	JT9D7Q	QQQ	4	11	5116	0	0.00	1	0.20
747251B	JT9D7Q	BKB	13	9	14288	3	0.21	1	0.07
747251B	JT9D7R4G2	BKB	5	10	5968	0	0.00	1	0.17
747273C	JT9D7F	ILT	1	9	1056	0	0.00	0	0.00
747287B	JT9D7Q	QQQ	1	7	844	0	0.00	0	0.00
747SP31	JT9D7A	DDA	2	5	1160	0	0.00	0	0.00
SUM					181648	26		24	
AVERAGE X (NORM)							0.14		0.13
STANDARD DEVIATION							0.03		0.03
RED RANGE							0.17		0.16
767	JT9D7R4D	LWZ	11	11	7098	0	0.00	1	0.14
767222	JT9D7R4D	RAB	19	11	12100	0	0.00	2	0.17
SUM					19198	0		3	
AVERAGE X (NORM)							0.00		0.16
STANDARD DEVIATION							0.00		0.09
RED RANGE							0.00		0.25
DC1040	JT9D20	BKB	18	7	10323	2	0.19	0	0.00
DC1040	JT9D20	NZT	1	8	687	0	0.00	0	0.00
SUM					11010	2		0	
AVERAGE X (NORM)							0.18		0.00
STANDARD DEVIATION							0.13		0.00
RED RANGE							0.31		0.00

TABLE 2. B-747/JT9D IN-FLIGHT SHUTDOWN MONTHLY PERFORMANCE

	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
	'88	'88	'88	'88	'88	'88	'88	'88	'88	'88	'88	'89	'89	'89	'89	'89	'89	'89
INDUSTRY	0.17	0.20	0.16	0.16	0.19	0.15	0.14	0.13	0.15	0.10	0.13	0.13	0.12	0.15	0.18	0.14	0.09	0.15
CTA	0.72	0.44	0.08	0.11	0.28	0.08	0.00	0.00	0.10	0.00	0.00	0.19	0.00	0.12	0.23	0.00	0.17	0.00
ABC	0.06	0.25	0.18	0.17	0.22	0.15	0.15	0.10	0.18	0.09	0.13	0.00	0.08	0.08	0.16	0.20	0.04	0.17
AAA	0.00	0.27	0.00	0.25	0.00	0.52	1.69	0.00	1.62	0.00	ND	0.00	0.00	0.00	0.00	ND	ND	ND
QQQ	0.45	0.20	0.07	0.00	0.20	0.04	0.11	0.06	0.17	0.13	0.21	0.13	0.14	0.23	0.04	0.11	0.03	ND
DEF	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BKB	0.10	0.09	0.24	0.20	0.16	0.17	0.09	0.19	0.16	0.11	0.15	0.13	0.08	0.04	0.10	0.10	0.12	0.17
DAR	ND	0.00	0.00	0.51	0.00	0.34	0.17	0.00	0.24	0.41	0.20	0.40	0.00	0.26	0.32	0.00	0.00	0.00
LWZ	0.05	0.14	0.09	0.12	0.10	0.13	0.16	0.19	0.14	ND	0.05	0.19	0.16	0.04	0.04	0.16	0.07	0.10
RAB	0.03	0.08	0.08	0.08	0.10	0.08	0.09	0.03	0.00	0.00	0.07	0.13	0.09	0.28	0.30	0.12	0.04	0.07
DDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
ILT	0.00	ND	0.00	0.00	0.00	0.00	ND	0.00	ND	ND	0.00	0.00	ND	ND	0.59	0.00	ND	0.40
JKL	ND	ND	ND	ND	ND	0.00	0.00	0.00	0.30	0.00	0.00	0.31	0.62	0.00	0.31	0.00	0.00	0.00
NNN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN
	'89	'89	'89	'89	'89	'90	'90	'90	'90	'90	'90	'90	'90	'90	'90	'90	'90	'91
INDUSTRY	0.17	0.12	0.09	0.13	0.21	0.14	0.15	0.10	0.19	0.12	0.20	0.16	0.16	0.11	0.20	0.18	0.17	0.15
CTA	0.08	0.08	0.08	0.09	0.26	0.09	0.00	0.00	0.20	0.21	0.09	0.00	ND	ND	0.31	0.00	0.55	0.08
ABC	0.06	0.09	0.07	0.17	0.26	0.26	0.18	0.16	0.18	ND	0.41	0.35	0.14	0.04	0.25	0.17	0.16	0.20
AAA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
QQQ	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DEF	0.04	0.11	0.00	0.11	0.08	0.05	0.06	0.04	0.43	0.17	0.26	0.05	0.22	0.00	0.13	0.09	0.00	0.06
BKB	0.25	0.12	0.13	0.02	0.25	0.08	0.19	0.13	0.13	0.10	0.14	0.16	0.16	0.21	ND	ND	ND	ND
DAR	0.36	0.00	0.23	0.24	0.20	0.00	0.00	0.00	ND	0.00	0.27	0.60	0.34	0.00	1.09	0.55	0.39	0.75
LWZ	0.10	0.11	0.09	0.09	0.17	0.04	0.15	0.04	0.00	0.00	0.07	0.04	0.04	0.08	0.13	0.17	0.22	0.12
RAB	0.11	0.10	0.06	0.19	0.05	0.10	0.05	0.00	0.12	0.10	0.02	0.04	0.13	0.04	0.02	ND	0.02	0.04
DDA	0.00	0.76	0.00	0.36	0.00	0.00	0.00	0.35	0.37	0.00	0.00	0.37	0.39	0.00	0.00	0.00	ND	0.00
ILT	0.32	ND	ND	0.00	ND	ND	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.19	0.20	0.12	0.18	0.18
JKL	1.02	ND	0.00	0.00	0.25	0.59	0.31	0.00	0.52	0.25	0.27	0.00	0.25	0.00	0.00	0.00	0.00	0.00
NNN	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.20	0.00	0.00

TABLE 3. B-747/JT9D ENGINE REMOVAL MONTHLY PERFORMANCE

	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL
	'88	'88	'88	'88	'88	'88	'88	'88	'88	'88	'88	'89	'89	'89	'89	'89	'89	'89
INDUSTRY	0.16	0.31	0.20	0.32	0.27	0.25	0.25	0.20	0.23	0.24	0.26	0.18	0.21	0.19	0.26	0.22	0.19	0.25
CTA	0.14	0.33	0.24	0.15	0.28	0.34	0.26	0.00	0.48	0.00	0.20	0.18	0.13	0.23	0.20	0.41	0.17	0.33
ABC	0.06	0.23	0.22	0.27	0.30	0.34	0.30	0.22	0.16	0.19	0.18	0.00	0.08	0.14	0.18	0.22	0.08	0.23
AAA	0.00	0.55	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND	0.00	1.32	0.00	0.00	ND	ND	ND
QQQ	0.19	0.28	0.08	0.15	0.17	0.22	0.14	0.17	0.21	0.14	0.32	0.04	0.25	0.10	0.38	0.20	0.18	ND
DEF	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BKB	0.22	0.28	0.17	0.10	0.24	0.25	0.27	0.21	0.20	0.18	0.20	0.23	0.25	0.13	0.14	0.12	0.21	0.23
DAR	ND	0.27	0.62	0.00	0.00	0.00	0.17	0.24	0.24	0.41	0.20	0.00	0.00	0.00	0.00	0.57	0.00	0.00
LWZ	0.10	0.14	0.14	0.16	0.14	0.13	0.03	0.00	0.05	ND	0.14	0.29	0.21	0.22	0.26	0.04	0.17	0.26
RAB	0.11	0.25	0.15	0.66	0.27	0.14	0.28	0.16	0.28	0.24	0.29	0.24	0.11	0.28	0.28	0.27	0.17	0.14
DDA	0.00	0.00	0.85	0.72	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	1.85	0.00	0.00	0.00	0.00	0.00
ILT	0.00	ND	0.00	0.00	2.25	0.00	ND	0.41	ND	ND	0.00	0.00	ND	ND	1.02	0.00	ND	3.01
JKL	ND	ND	ND	ND	ND	0.00	0.00	0.33	0.30	0.29	0.77	0.31	0.31	0.00	0.31	0.27	0.28	0.00
NNN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN
	'89	'89	'89	'89	'89	'90	'90	'90	'90	'90	'90	'90	'90	'90	'90	'90	'90	'91
INDUSTRY	0.24	0.23	0.22	0.26	0.23	0.23	0.23	0.21	0.25	0.21	0.31	0.26	0.29	0.24	0.20	0.18	0.17	0.15
CTA	0.24	0.17	0.23	0.27	0.56	0.34	0.13	0.16	0.20	0.21	0.44	0.07	ND	ND	0.31	0.00	0.55	0.08
ABC	0.19	0.16	0.21	0.27	0.33	0.16	0.34	0.14	0.28	ND	0.26	0.31	0.26	0.19	0.25	0.17	0.16	0.20
AAA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
QQQ	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DEF	0.16	0.27	0.30	0.26	0.22	0.41	0.29	0.12	0.37	0.05	0.46	0.10	0.32	0.24	0.18	0.14	0.18	0.30
BKB	0.27	0.31	0.23	0.22	0.17	0.14	0.14	0.26	0.28	0.22	0.19	0.26	0.28	0.29	ND	ND	ND	ND
DAR	0.54	0.00	0.23	0.00	0.20	0.43	0.00	0.00	ND	0.00	0.27	0.19	0.00	0.20	0.00	0.00	0.00	0.00
LWZ	0.20	0.19	0.17	0.28	0.00	0.09	0.21	0.17	0.22	0.08	0.33	0.26	0.18	0.20	0.27	0.23	0.09	0.12
RAB	0.20	0.20	0.15	0.13	0.13	0.15	0.20	0.16	0.05	0.25	0.26	0.18	0.30	0.17	0.27	ND	0.16	0.21
DDA	0.00	0.00	0.35	0.36	0.00	0.49	0.00	0.35	0.37	0.00	0.37	0.37	0.39	0.38	0.00	0.00	ND	0.00
ILT	0.00	ND	ND	0.63	ND	ND	0.00	0.00	0.00	0.16	0.26	ND	0.00	0.19	0.12	0.12	0.53	0.43
JKL	0.25	ND	0.21	0.53	0.25	0.59	0.31	0.28	0.26	0.25	0.27	0.83	0.49	0.00	0.52	1.02	0.22	0.20
NNN	ND	ND	0.00	0.00	0.00	0.38	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.22	0.00	0.41	0.00	0.26

STEP 3: SUMMARY DATA SHEET DEVELOPMENT

For each month, an operator's reported rates of in-flight shutdowns and engine removals were compared with the calculated industry norm for a particular airframe/engine combination. A summary data sheet was developed for both in-flight shutdowns and unscheduled engine removals for each airframe/engine application for the 36 month trending period. The fact that the fractional denominator is less than 36 indicates that in one or more months no data (ND) were available for a given airline. Table 4 and 5 are the data summary sheets for the B-747/JT9D engine in-flight shutdowns and unscheduled engine removals, respectively.

TABLE 4. B-747/JT9D IN-FLIGHT SHUTDOWNS 36 MONTH DATA SUMMARY SHEET			
<u>CARRIER</u>	<u>AVERAGE NUMBER OF AIRCRAFT</u>	<u>NUMBER OF EXCEEDANCES</u>	<u>% OF EXCEEDANCES</u>
CTA	8	11/34	32%
ABC	34	19/35	54%
AAA	1	5/14	36%
GGG	21	9/17	53%
DEF	21	4/18	22%
BKB	40	19/32	59%
DAR	4	18/34	53%
LWZ	17	8/35	23%
RAB	31	4/35	11%
DDA	2	7/35	20%
ILT	2	7/24	29%
JKL	6	12/30	40%
NNN	3	2/16	13%

TABLE 5. B-747/JT9D ENGINE REMOVALS 36 MONTH DATA SUMMARY SHEET			
<u>CARRIER</u>	<u>AVERAGE NUMBER OF AIRCRAFT</u>	<u>NUMBER OF EXCEEDANCES</u>	<u>% OF EXCEEDANCES</u>
CTA	8	18/34	53%
ABC	34	11/35	31%
AAA	1	3/14	21%
GGG	21	4/17	24%
DEF	21	11/18	61%
BKB	40	15/32	47%
DAR	4	8/34	24%
LWZ	17	10/35	29%
RAB	31	13/35	37%
DDA	2	13/35	37%
ILT	2	7/24	29%
JKL	6	22/30	73%
NNN	3	4/16	25%

Percentage of monthly exceedances is calculated for each of the carriers. The carriers are then ranked based on their calculated percentage of monthly exceedances.

STEP 4: SELECTION OF AIRLINES TO STUDY

The selection of specific airlines to trend for component failures is a subjective judgment with emphasis placed upon in-flight shutdown exceedance percentages and engine removal exceedance percentages. The number of months the airline has reported data and the average number of aircraft operated are other factors which were considered. The purpose of this macro analysis is to determine which airlines may be having engine reliability problems.

STEP 5: COMPONENT FAILURE ANALYSIS

Once the airline carriers are identified and the macro scan ranking completed, a detailed analysis of component failures for each of the engine models is conducted. A printout is requested on JT9D, CF6, and PT6 engine component failures as recorded in the SDRs. This printout covered the reporting time frame of January 1986 through November 1991. Specific information provided included the following: operating condition that occurred, which engine incurred the damage, aircraft model and serial number, engine model and serial number, air carrier, and date of incident. A brief narrative was included describing the incident and corrective action taken. This narrative also documented whether a takeoff was aborted, a flight turn back occurred, if the flight was diverted, and whether or not an engine flameout occurred. Each of these flight occurrences was considered significant in determining the severity of the specific engine component failure.

The information from this printout was used to develop each of the JT9D, CF6, and PT6 engine component failure trends. The trends identify the component failures and number of failure occurrences. It should be noted this in-depth component failure analysis was conducted only on those air carriers identified during step four as having consistently higher than normal in-flight shutdown and unscheduled engine removal rates for the 36-month trending period.

DISCUSSIONS AND RESULTS

TRENDING RESULTS

Data for the 36-month period from February 1988 to January 1991 were collected for the following airframe/engine configurations: B-747/JT9D, B-767/JT9D, DC-10/JT9D, A-300/CF6, B-767/CF6, DC-10/CF6, BE-1900/PT6, BE-99/PT6, DHC-6/PT6, DHC-7/PT6, EMB-110/PT6, and SH SD-330/PT6. For each airframe/engine combination, the industry average and standard deviation for in-flight shutdowns and unscheduled engine removal rates per 1000 hours of operating time were calculated. For this study the industry normal range is the monthly pooled average plus one standard deviation. Anything greater than one standard deviation from the industry average was considered to be outside the norm and marked as an exceedance to the industry norm. Monthly actuarial trending results for each airframe/engine combination are contained in Appendix A.

With the monthly industry norms calculated, bar charts comparing individual airlines to the monthly norms for the respective airframe/engine combinations were developed. Figures 1 and 2 are examples of such charts. The negative bar indicates the airline did not report data for that particular month. The percentage of months that each airline operated over the industry's normal rate of in-flight shutdowns and unscheduled engine removals was calculated. The airlines which most often exceeded the monthly normal rates were identified for each airframe/engine combination. Again, it should be noted that the ranking of the airlines by percent of monthly exceedances was necessary to facilitate the identification of engine components causing the exceedances and not to target individual airlines in any way.

B-747 IN-FLIGHT SHUTDOWNS 2/88 THRU 1/91

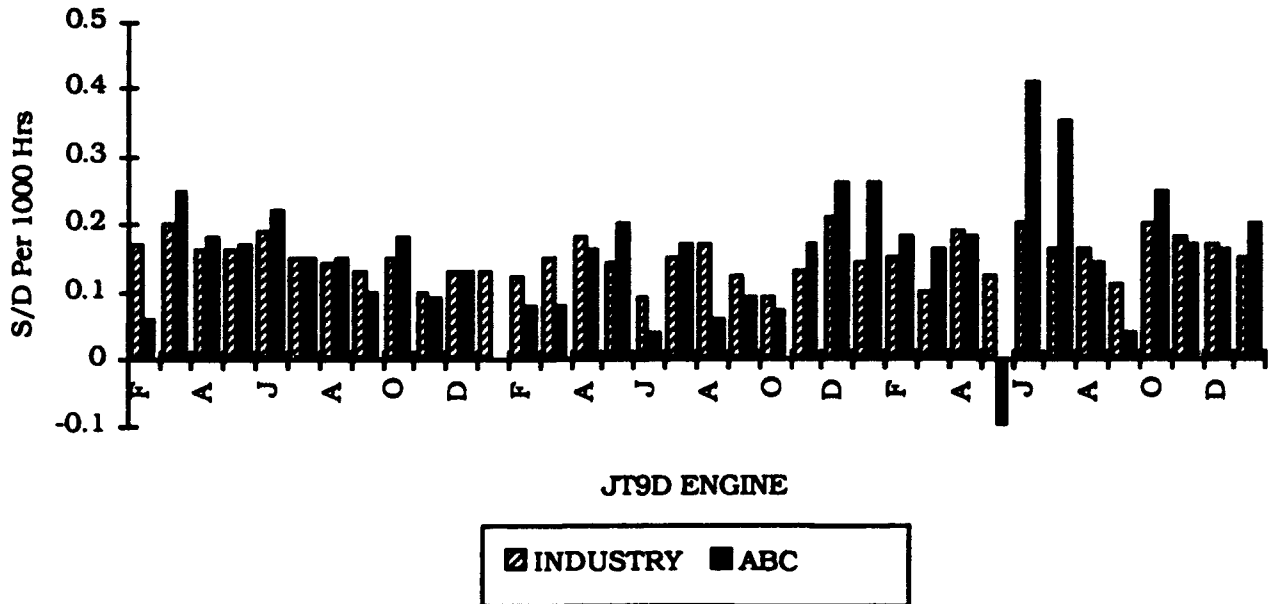


FIGURE 1. SAMPLE DATA COMPARING AIRLINE ABC TO THE REST OF THE INDUSTRY FOR B-747 JT9D IN-FLIGHT ENGINE SHUTDOWN RATES.

B-747 ENGINE REMOVALS 2/88 THRU 1/91

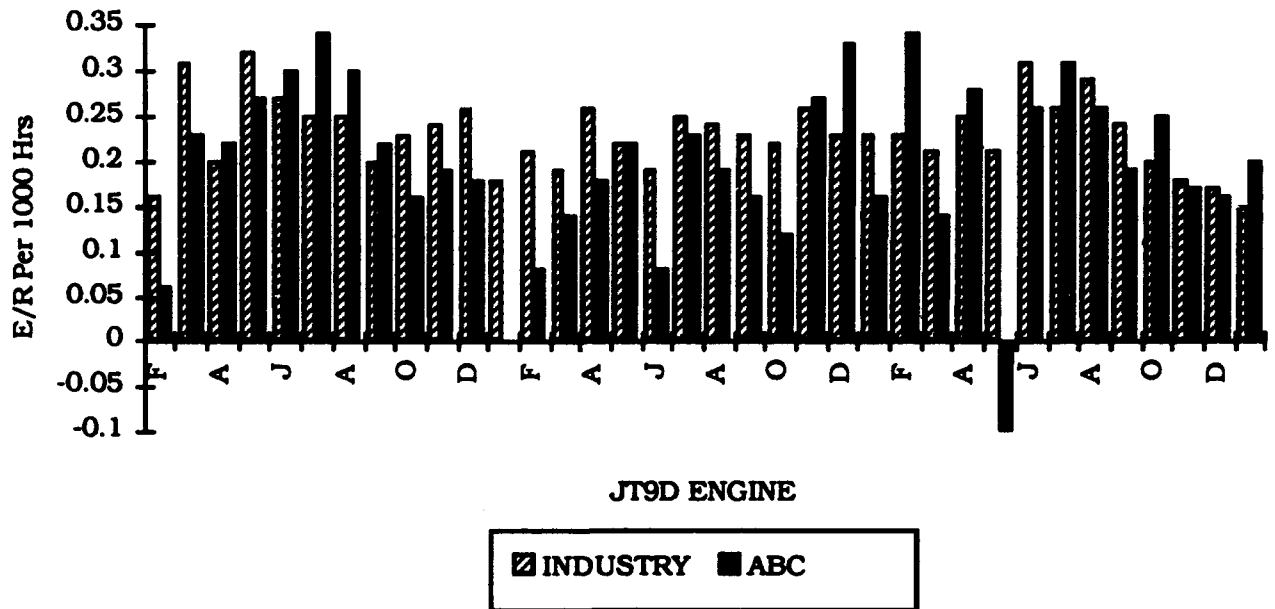


FIGURE 2. SAMPLE DATA COMPARING AIRLINE ABC TO THE REST OF THE INDUSTRY FOR B-747 JT9D UNSCHEDULED ENGINE REMOVAL RATES.

MACRO SCAN RESULTS

A masked listing of each of the airline macro scans is contained in Appendix B. Based on the results from the actuarial analysis, seven airlines operating the JT9D engines, ten airlines operating the CF6 engines, and 21 airlines operating the PT6 engines were further analyzed to identify which engine components caused the higher than normal shutdown and unscheduled engine removal rates. The airlines were chosen based on the in-flight shutdown percent exceedance, unscheduled engine removal percent exceedance, number of aircraft in the airline's inventory, and how many months data had been reported. Table 6 lists the masked airlines and their airframe models.

TABLE 6. MASKED AIRLINES IDENTIFIED FOR COMPONENT PERFORMANCE ANALYSIS

CONFIGURATION OF PERFORMANCE SUMMARY					
JT9D B-747	JT9D B-767	JT9D DC-10	CF6 A-300	CF6 B-767	CF6 DC-10
ABC 999 BKB DEF LWZ	RAB LWZ	BKB NZT	ABC DDA XYZ CTA	FPC SSS DDA GGA	DEF DDA TMR RAB
PT6 BE-1900	PT6 BE-99	PT6 DHC-6	PT6 DHC-7	PT6 EMB-110	PT6 SH SD-330
OTR CJU EKV NPA PQB	OTR YHS AIT JJJ	SLP WGR KNY GOP CBA	MAB RCW URW GLW	MAB QXC TUC	EKV IMX LOZ

JT9D ENGINE COMPONENT FAILURE ANALYSIS

The JT9D engine inventory reviewed in this study was installed on three different airframes which included DC-10, B-747 and B-767. The review of the JT9D engine and these three airframes involved fourteen carriers, operating on a monthly average of 883 JT9D engines during the period of observation. The actuarial trending of in-flight shutdowns and unscheduled engine removals resulted in seven air carriers being examined more closely for specific component failure incidents.

The JT9D-7 inventory was introduced into operational service in the mid-1960's and had a rated thrust of 45,600 pounds. Various thrust growth models of the -7 engine were developed to include the -7F at 48,000 pounds of thrust, the -7Q at 53,000 pounds of thrust and the -7R4G2 with 54,750 pounds of thrust. The JT9D-7R4G engine is considered by PWA to be a significant growth model of the engine, not just in thrust produced but in reliability enhancements. Therefore, where possible, the data for the JT9D-7R4G has been compared to the remainder of the JT9D inventory. This comparison is shown in table 7 by major groupings of components. There were significantly fewer number of JT9D-7R4G2 incidents when compared to the complete JT9D inventory, as shown in table 7. The percentage of bearing incidents (11 percent) for the 7R4G2 inventory was greater than the complete JT9D inventory, as was the percentage of fuel/oil system incidents (28 percent). However, overall the 7R4G inventory exhibited high reliability.

TABLE 7. JT9D ENGINE INVENTORY FAILURE INCIDENT ANALYSIS FOR SELECTED CARRIERS				
COMPONENT	# INCIDENTS JT9D TOTAL*	REPORTED JT9D-7R4G	% OF TOTAL* JT9D	INCIDENTS JT9D-7R4G
BEARINGS	35	2	4%	11%
AIRFOILS	80	1	10%	6%
CASES	13	0	2%	0%
FUEL / OIL SYSTEMS	84	5	10%	28%
CONTROLS & ACCESSORIES	366	7	44%	39%
OTHER	254	3	30%	16%
TOTAL	832	18		
* Total includes JT9D-7R4G information				

Review of the engine bearing failure incidents showed the #3 bearing to exhibit the highest number of failures with fifteen incidents reported. The failure modes documented involved leaking breather seals, carbon plugged scavenge tubes and cracked bearing compartments. For the six reported #4 bearing failure incidents, failed oil pressure lines, packings and the housing were the most common reported incidents.

Of the airfoil failure incidents reported, the eighth stage compressor blades and first stage turbine blades were the most prevalent. Ten eighth stage compressor blade failures were reported, with some failures in the root area of the blades. The thirty-seven first stage turbine blades reported generally failed one inch above the platform, although some failed in the root area. The turbine blade failures were due to material stress not foreign object damage (FOD).

The review of the failure data of the JT9D engine inventory showed controls and accessories to be a dominant failure trend. Of the 832 reported incidents for the five year component trending period, 366 (44 percent) of all reported failures involved controls and accessories. Table 8 exhibits the type of component failures reported. Of the controls and accessories reviewed, the following five accessories exhibited the strongest trends: fuel control, fuel pump, engine vane controller (EVC), TT2 sensor and pressure ratio bleed control (PRBC). The fuel control and fuel pump each had numerous individual failure incidents as well as 25 reported incidents of removal of both items. Dual removals indicate the diagnostic trouble shooting information and practices were not sufficiently efficient to isolate fuel management problems to one particular item. In addition, dual removals of fuel controls and fuel pumps generate at least one good item to depot repair, where a RETEST OK event occurs. This necessarily increases the workload and costs to the accessory backshop repair area.

**TABLE 8. JT9D ENGINE COMPONENT FAILURE INCIDENTS
FOR SELECTED CARRIERS**

COMPONENT	NUMBER OF INCIDENTS	TOTAL INCIDENTS
BEARINGS		
#1 Bearing	4	35
#2 Bearing	4	
#3 Bearing	15	
#4 Bearing	6	
Gearbox Bearings	6	
AIRFOILS		80
Fan Blades	9	
5th Stage Compressor Blades	3	
7th Stage Variable Vane arm/pin	3	
8th Stage Compressor Blades	10	
13th Stage Compressor Blades	4	
15th Stage Compressor Blades	1	
1st Stage HPT Blades	37	
2nd Stage HPT Blades	8	
1st Stage HPT Vanes	1	
2nd Stage HPT Vanes	4	
CASES		13
Fan Case	4	
Intermediate Case	1	
Diffuser Case	4	
Combustor Case	2	
Exhaust Case	2	
FUEL / OIL SYSTEMS		84
Fuel Filter	28	
Fuel Line	9	
PS-4 Tube	8	
Oil Contamination	5	
Oil Cap Missing	12	
Oil Breather Tube Packing	3	
Oil Filter	19	
CONTROLS AND ACCESSORIES		368
Fuel Control	47	
Fuel Control / Fuel Pump	25	
Fuel Pump	57	
Fuel Pump Sheared Shaft	13	
Engine Vane Controller	82	
Engine Electronic Control	1	
TT2 Sensor	22	
Thrust Control Computer	1	
Pressure Ratio Bleed Control	32	
Bleed Converter Valve	19	
8th Stage Bleed Valve	3	
15th Stage Bleed Valve	5	
Flapper Valve	1	
HP Butterfly Valve	1	
TCC Control Valve	1	
N2 Tach Generator	7	
Constant Speed Drive	5	
Main Gearbox	2	
Aux Gearbox	1	
Angle Gearbox	13	
Angle Gearbox Coverplate Stud	9	
Hydraulic Pump	7	
Fuel / Oil Cooler	7	
Oil Pump	5	
OTHER		254

The historical failure pattern for JT9D engine fuel controls is shown in figure 3. The number of failure incidents increased in 1990 and 1991 over the previous five years. Typical fuel control part numbers involved included P/N 748000-5 and P/N 77-333-3. The fuel controls were generally removed for adverse performance impact upon the engine. Some specific failures were reported as broken PS4 air line and sheared drive shaft. Occasionally, adjustments could be made for the idle speed being too low. However, most of the incidents resulted in fuel control removal with depot backshop testing required. Table 9 shows the impact upon the aircraft flight profile by type of fuel control induced engine malfunction. The most common occurrence was engine flameout while in cruise. A total of 28 flameouts, or 39 percent of the total incidents, were recorded. Compressor stalls frequently occurred at the start of descent and power surges were recorded while in cruise.

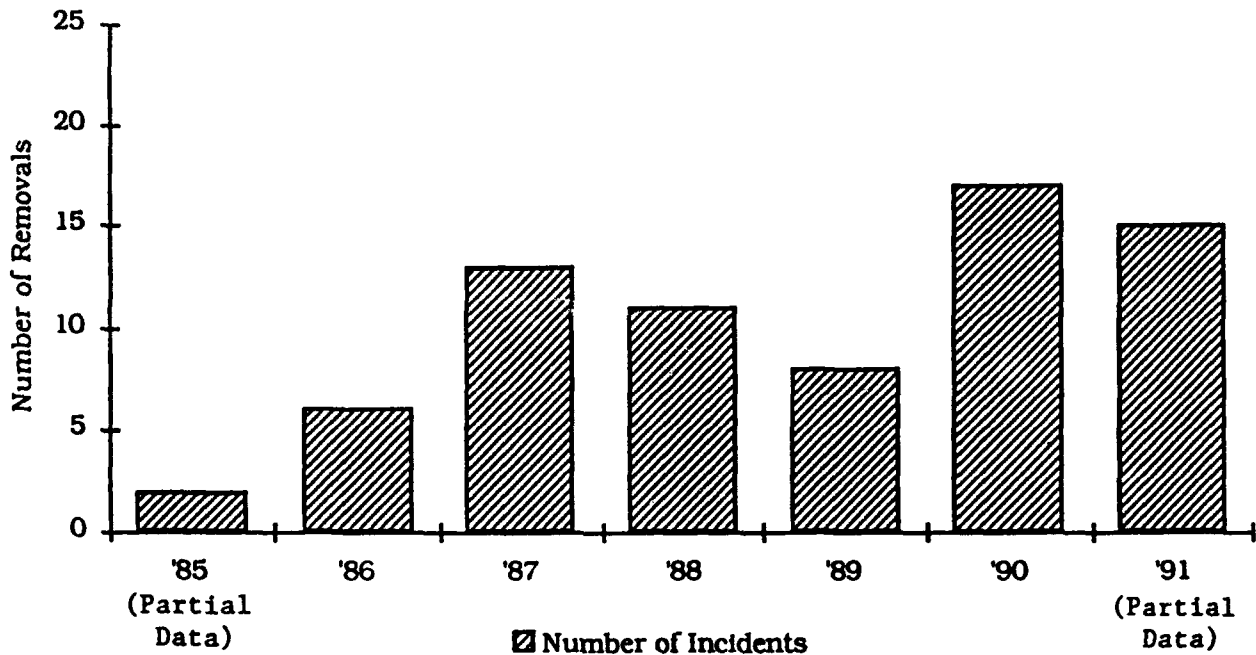


FIGURE 3. JT9D ENGINE FUEL CONTROL REMOVALS BY YEAR FOR SELECTED CARRIERS

The JT9D engine fuel pump exhibited 95 failure incidents, or 26 percent of all reported controls and accessories incidents. The most frequent failure mode was fuel pump sheared shafts with thirteen specific incidents reported. A histogram of these 95 reported incidents is included as figure 4. The fuel pump sheared shaft incidents peaked in 1986 and 1987 for the data reviewed. Also documented was the tendency for the fuel pump shaft splines to become stripped or severely worn, thus disengaging the pump from operation. Typical fuel pump part numbers involved were P/N 373401-26, P/N 706800 and P/N 389400.

The EVC removals recorded 82 failure incidents over the observation period which represented 22 percent of all controls and accessories incidents. The incidents have been increasing since 1988, peaking at 23 incidents in 1990. Figure 5 shows this historical failure performance. The EVC filter was often changed in addition to the removal of the unit. There were several incidents of air and fuel lines broken at the unit. Table 10 reviews the impact upon aircraft operation resulting from EVC failures. The most frequent impact was to create engine compressor stalls with resultant shutdowns or flameouts, occurring during in cruise operation and turbulent weather conditions. Engine flameouts also occurred when initiating a descent flight profile. The part number for most EVC incidents was P/N 747955-5.

TABLE 9. JT9D ENGINE FUEL CONTROL FAILURE INCIDENTS FOR SELECTED CARRIERS						
ENGINE OPERATIONAL CHARACTERISTIC	TAKEOFF	CLIMBOUT	CRUISE	DESCENT	APPROACH	TOTAL
FLAMEOUT	--	8	17	3	--	28
SHUTDOWN	2	--	3	1	1	7
STALL / SHUTDOWN	--	2	4	8	--	14
POWER LOSS / RPM ROLLBACK	3	4	1	--	2	10
INCORRECT THROTTLE MOVEMENT / SETTING	--	--	3	--	1	4
POWER SURGES	1	1	7	--	--	9
TOTAL	6	15	35	12	4	72

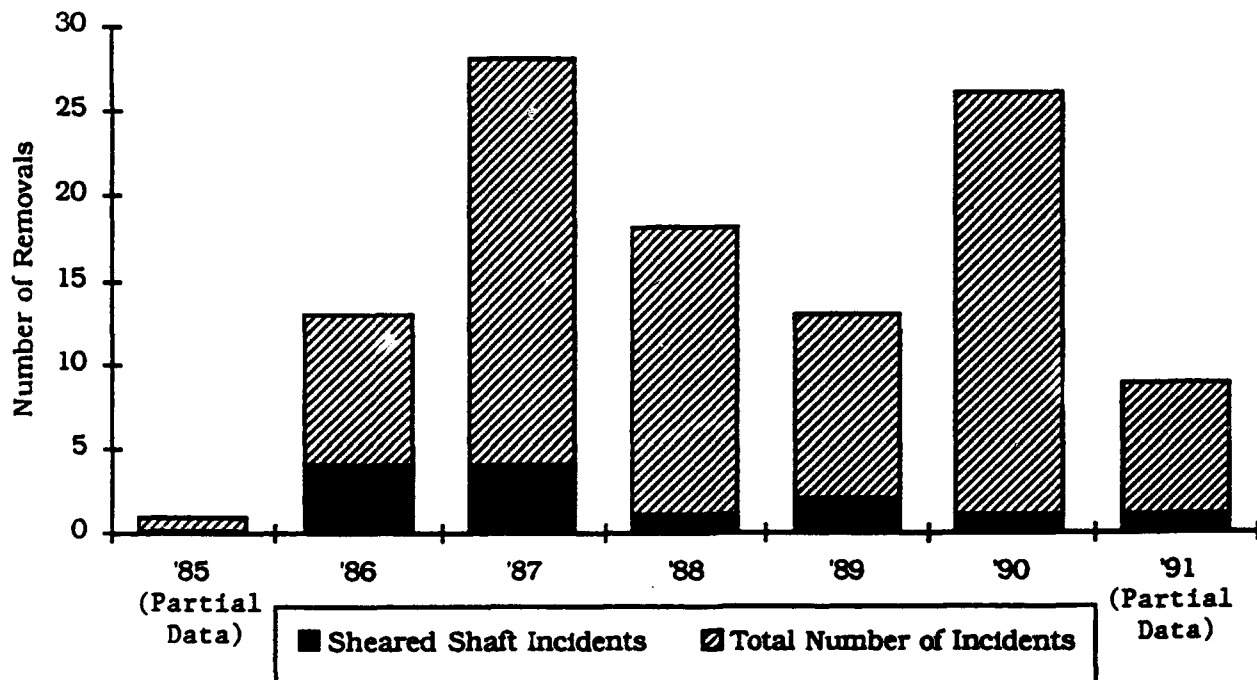


FIGURE 4. JT9D ENGINE FUEL PUMP REMOVALS BY YEAR FOR SELECTED CARRIERS

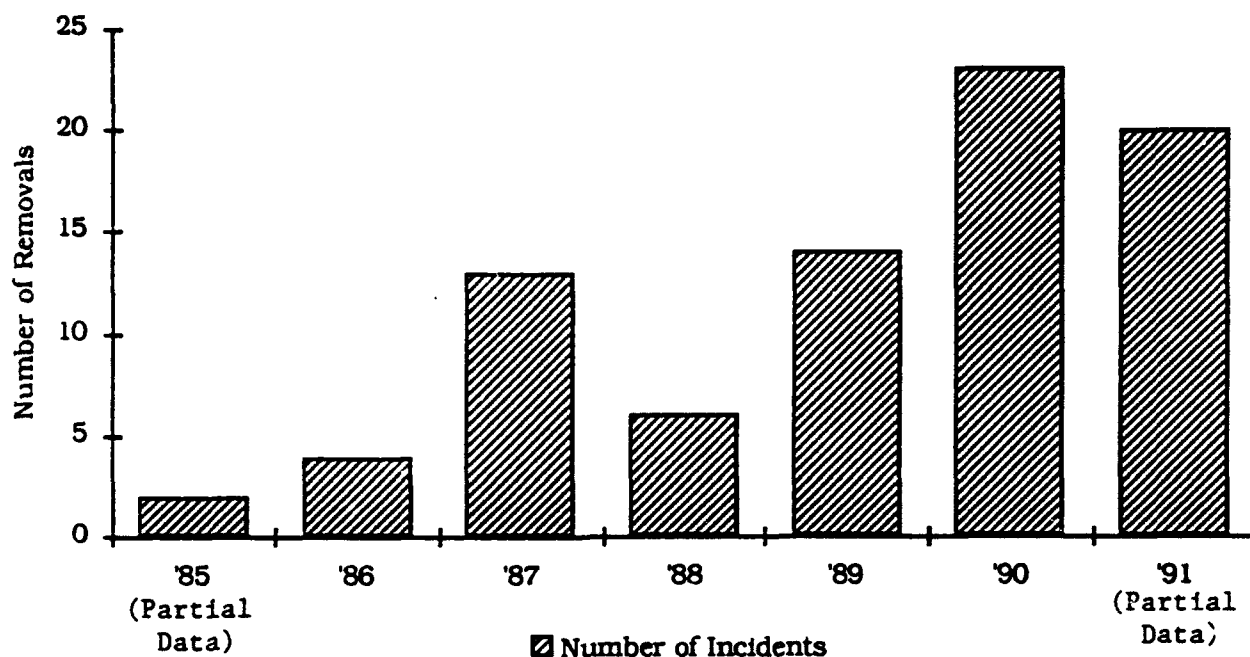


FIGURE 5. JT9D ENGINE VANE CONTROL REMOVALS BY YEAR FOR SELECTED CARRIERS

TABLE 10. JT9D ENGINE VANE CONTROLLER FAILURE INCIDENTS FOR SELECTED CARRIERS						
ENGINE OPERATIONAL CHARACTERISTIC	TAKEOFF	CLIMBOUT	CRUISE	DESCENT	APPROACH	TOTAL
FLAMEOUT	1	4	5	7	1	18
SHUTDOWN	--	1	2	1	--	4
STALL / SHUTDOWN / FLAMEOUT	2	13	21	7	--	43
SMOKE / FUMES IN CABIN	3	3	2	--	--	8
RPM SPOOLDOWN / SURGE	1	2	3	--	--	6
OIL OUT BLEEDS / HIGH CONSUMPTION	3	--	--	--	--	3
TOTAL	10	23	33	15	1	82

The TT2 sensor exhibited 22 failure incidents for the operational period reviewed. Of these 22 failures, over 75 percent of them produced flameouts or compressor stalls with resultant engine shutdowns. Restarts were attempted on only about 50 percent of the documented events and several of those were unsuccessful on the initial attempt. Figure 6 shows the historical failure trend of the TT2 sensor.



FIGURE 6. JT9D ENGINE TT2 SENSOR REMOVALS BY YEAR FOR SELECTED CARRIERS

The PRBC exhibited 32 failure incidents over the period reviewed. Figure 7 shows the number of failure incidents peaking in 1987 then stabilizing. Failure of this item typically resulted in compressor stalls and subsequent engine shutdowns to avoid over temp damage to the turbine. Shutdowns or flameouts occurred in 48 percent of the reported incidents.

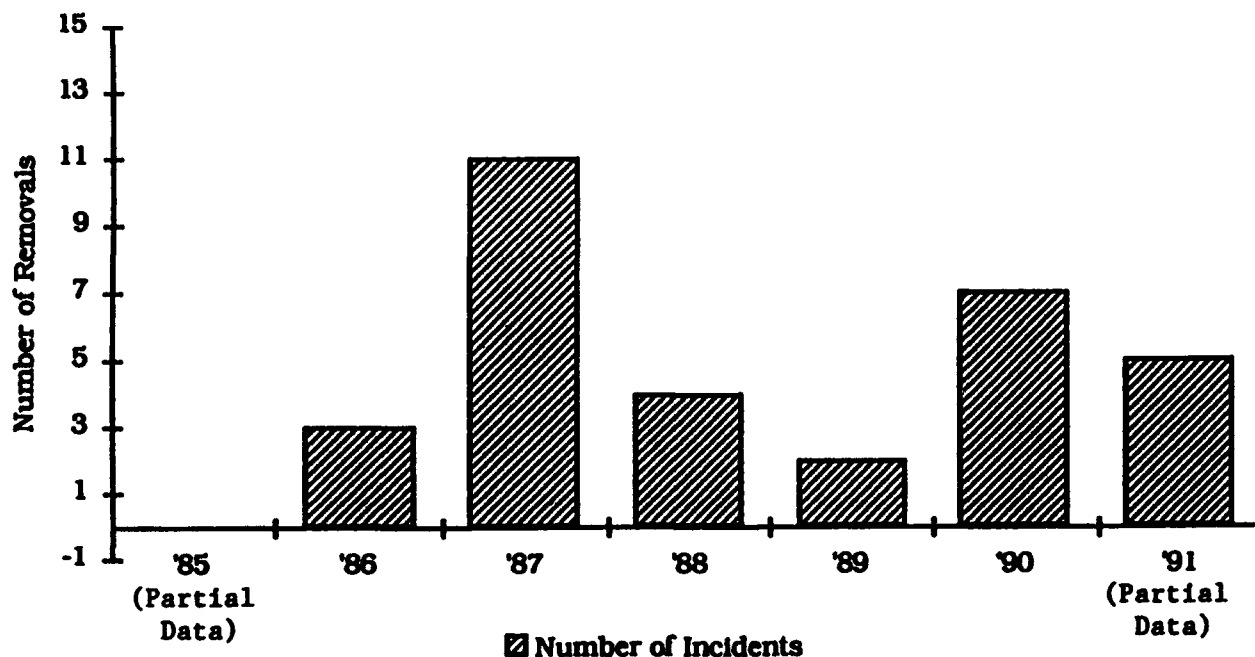


FIG. 7. JT9D ENGINE PRESSURE RATIO BLEED CONTROL VALVE REMOVALS BY YEAR FOR SELECTED CARRIERS

By using the data base created from documenting JT9D engine reported failure incidents, an engine serial number search can be made to determine the failure history of specific serial numbered engines. This engine serial number search provides documented information on trouble-shooting procedures, technical data inadequacies, hard failures of specific components and maintenance practices. Table 11 shows a series of reported incidents over a five month period in 1987 of the trouble shooting problem of a JT9D engine experiencing compressor stalls and flameouts. The engine was ultimately replaced after the removal of several controls and accessories.

TABLE 11. JT9D ENGINE TROUBLE-SHOOTING, ENGINE S/N: XXXXXX					
A / C TYPE: B-747, ENGINE S/N: XXXXXX					
ENGINE PARAMETERS	DATES		OF	INCIDENTS	
	06/12/87	07/20/87	07/27/87	11/08/87	06/24/88
COMPRESSOR STALL	Y	Y	N	N	Y
POWER REDUCTION AND/OR THROTTLE MOVEMENT	Y	Y	Y	Y	Y
FLAMEOUT	N	N	N	Y-2	N
ENGINE SHUTDOWN	Y	Y	Y	N	Y
EGT RISE (DEGREE C)	Y	N	800	N	N
N1 / N2 DROP	N	N	N	N	N
ENGINE VIB MEASUREMENT	--	--	--	--	--
OIL PRESSURE DROP	--	--	--	--	--
EPR DROP	Y	N	Y	N	N
RESTART ATTEMPT (YES / SUCCESSFUL)	Y/S	Y/S	Y/S	Y/S	N
INFLIGHT BLEED CK REQ	N	N	N	N	N
COMPONENTS REPLACED:	-TT2 SENSOR	-MAIN OIL SCREEN	-TT2 SENSOR	-FUEL CONTROL FUEL PUMP MAIN FUEL PUMP FILTER	-REPL'D ENGINE

The data base also permits the historical review of specific engine components, such as the JT9D engine fuel control shown in table 12. The malfunction impact upon other engine parameters can be used to adjust trouble shooting guidelines for the fuel control.

The tracking of specific engine serial numbers could also be used to review the maintenance events preceding a hard failure to determine what might have contributed to the failure event. Table 13 shows a specific engine serial number series of reported events prior to the failure of sixth stage compressor blade locks, which produced significant high pressure compressor damage.

Information from this data bank can also provide insight into maintenance practices. Table 14 shows the difficulties encountered on a JT9D engine angle gear box repair.

The JT9D engine has a proven reliability record and this actuarial review did not document any serious, safety-of-flight component failure patterns. However, the actuarial analysis did document some reliability problems, some of which are being worked by the prime engine manufacturer, requiring prompt installation of improved reliability configurations.

TABLE 12. JT9D ENGINE TROUBLE-SHOOTING, FUEL CONTROL									
DATE	A/C	COMP STALL	POWER REDUCTION/ THROTTLE MOVEMENT	ENGINE FLAME- OUT	ENGINE SHUT- DOWN	EGT RISE DEGREE C	N1/N2 DROP	RESTART ATTEMPT	OIL PRESSURE
3/11/91	B-747	Y	UNK	Y	N	840	UNK	Y SUCCESSFUL	UNK
11/20/87	B-747	N	Y	N	Y	UNK	UNK	Y SUCCESSFUL	UNK
03/28/90	B-747	N	UNK	Y	Y	UNK	UNK	Y UNSUCCESSFUL	25 PSI
08/13/90	B-747	N	UNK	N	N	HIGH	N1	N	UNK
09/29/89	B-747	Y	UNK	N	Y	1000	UNK	N	UNK
07/16/90	B-747	N	UNK	Y	Y	UNK	N1	Y UNSUCCESSFUL	14 PSI

TABLE 13. JT9D ENGINE TROUBLE-SHOOTING, ENGINE S/N YYYYYY				
A / C TYPE: DC-10, ENGINE S/N: YYYYYY				
ENGINE PARAMETERS	DATES		OF	INCIDENTS
	06/24/88	07/29/88	08/19/88	10/28/88
COMPRESSOR STALL	Y	Y	Y	Y
POWER REDUCTION AND/OR THROTTLE MOVEMENT	Y	N	N	N
FLAMEOUT	Y	Y	Y	N
ENGINE SHUTDOWN	N	N	N	Y
EGT RISE (Degree C)	1000	950	N	1000
N1 / N2 DROP	N	N	N	N
ENGINE VIB MEASUREMENT	--	--	Y	N
OIL PRESSURE DROP	--	--	--	--
EPR DROP	N	N	N	N
RESTART ATTEMPT (YES / SUCCESSFUL)	Y/S	Y/S	Y/N	Y/S
INFLIGHT BLEED CK REQ	N	Y	N	N
COMPONENTS REPLACED:	CND	CND	-MAIN OIL SCREEN	-6TH STG COMP BLADE LOCKS FAILED; HPC DAMAGE

TABLE 14. JT9D ENGINE TROUBLE-SHOOTING, ENGINE S/N XXXYYY				
A / C TYPE: B-747, ENGINE S/N: XXXYYY				
ENGINE PARAMETERS	DATES	OF INCIDENTS		
	08/03/87	08/24/87	11/06/87	11/06/87
COMPRESSOR STALL	N	N	N	N
POWER REDUCTION AND/OR THROTTLE MOVEMENT	N	Y	N	N
FLAMEOUT	N	Y	N	N
ENGINE SHUTDOWN	Y	N	Y	Y
EGT RISE	N	N	N	N
N1 / N2 DROP	N	N	N	N
ENGINE VIB MEASUREMENT	--	--	--	--
OIL PRESSURE DROP	Y	--	Y	Y
EPR DROP	N	N	N	N
RESTART ATTEMPT (YES / SUCCESSFUL)	N	Y/S	N	N
INFLIGHT BLEED CK REQ	N	N	N	N
COMPONENTS REPLACED:	-ANGLE GEARBOX COVERPLATE BOLT INSERT PULLED FROM GEARBOX	-FUEL FILTER	-ANGLE GEARBOX HELICOIL REPL'D	-ANGLE GEARBOX LINE LEAK

The JT9D engine SDR review identified three hard failure items: the #3 main bearing, the eighth stage compressor blade, and the fuel pump shaft. Six of the fifteen #3 main bearing failures were due to a quality control problem which PWA has since corrected. The remaining nine failures exhibited various failure modes, however due to the seriousness of a #3 bearing failure, consideration should be given for a redesign of the #3 main bearing. There were ten incidents reported on the eighth stage compressor blade. All the failures occurred in the root area of the blade, were self-induced and caused excessive damage to the compressor and some damage to the turbine. The implications associated with the extensive downstream damage and maintenance repair costs indicate the eighth stage compressor blade is a candidate for redesign. Airlines reported 95 fuel pump failures and specifically identified a fuel pump sheared shaft in thirteen incidents. The number of incidents identified by the airlines of the fuel pump shaft failures warrants an investigation by the engine manufacturer as to the feasibility of a redesign.

Several wear and tear failure patterns were evident, however, PWA has developed reliability modifications and is awaiting complete implementation by the airlines. There were 37 reported incidents for first stage turbine blade failures. PWA has modified the design of the blades using DS material designated as PWA 1422 and has made this new material available to the airlines for several years. This material offers improved stress rupture properties and thereby enables first stage turbine blades to withstand the higher than normal turbine inlet temperatures associated with compressor stalls. The PWA 1422 blades are the only replacement blades available and are being incorporated into the airlines inventory through attrition. The airlines reported 82 incidents related to the EVC accessory. The number of failures per year has steadily increased over the past five years. As a result of the limited reliability of the EVC and other controls and accessories, PWA has incorporated numerous reliability enhancements in the growth model JT9D-7R4G engine. The EVC has been redesigned for the JT9D-7R4G engine and modifications are available to upgrade the engine EVC on the older engine models. Implementation of the reliability

modifications in the EVC will greatly decrease the number of in-flight shutdowns and unscheduled engine removals, thus increasing the overall reliability of the JT9D engine.

Due to the concern expressed by air carriers for engine cases lacking assigned service lives, an increased emphasis to identify all engine case failures was pursued. To this effect thirteen JT9D engine case failures were identified from the component trending period of February 1988 through January 1991. A complete review, conducted with engineers at PWA, summarized and prioritized the criticality of these case failures. Discussions included background information on engine cases, case thickness, the manufacturing and welding processes, material properties, case failure modes, and current inspection methods. The greatest concern experienced by PWA was the integrity of a weld repair being accomplished by the air carriers. Their concern centers around the inability of the current inspection procedure to detect internal defects (i.e. cracks and voids) of repair welds, particularly those welds on the JT9D diffuser case exceeding 1.5 inches in length and involving the case rail area. SAIC worked closely with PWA to develop a preliminary ultrasonic inspection procedure to validate the structural integrity of repair welds on the JT9D engine diffuser case. These results are documented elsewhere in this report.

The SDR review also identified some diagnostic troubleshooting problems. The most prevalent diagnostic troubleshooting observation involved dual removals of engine fuel controls and engine fuel pumps for suspected malfunctions. Diagnostic troubleshooting guidelines had previously been published by PWA on the JT9D engine for air carrier maintenance personnel. However, the technical data was considered too voluminous and complicated by the air carriers and has not satisfied its intended purpose. There is not an on-board engine diagnostic system available for the JT9D engine, and that lack of capability severely limits the amount of fault isolation possible on controls and accessory items. The current practice of the JT9D operators is to make dual or even triple control/accessory removals to assure the source of the in-flight compressor stall or flameout has been removed.

The analysis identified maintenance practices as contributing to in-flight shutdowns. Typical maintenance practice problems included; engine oil cap unsecured, oil screen studs pulled loose and oil seals pinched. These practices often resulted in loss of power and/or loss of oil with the resultant engine shutdown and unscheduled engine removal. PWA incorporated a flapper valve in the oil tank of the JT9D-7R4G growth model in order to prevent oil loss if the oil cap is unsecured. The flapper valve modification is available to all air carriers to incorporate into the older JT9D engine models. The flapper valve, however, does make the task of adding oil to the engine more difficult and time consuming.

CF6 ENGINE COMPONENT FAILURE ANALYSIS

The CF6 engine inventory is operated on three different airframes: A-300, B-767 and DC-10 aircraft. Sixteen air carrier and aircraft combinations were reviewed involving eleven air carriers. The component failure incidents on twelve CF6/airframe combinations were recorded and trended. These air carriers operated on an average of 792 CF6 engines per month.

The initial CF6 engine represents technology from the late 1960's and early 1970's. This review of the CF6 engine inventory included the CF6-6, CF6-50 and CF6-80 engine models. The CF6-6 engine typically develops 39,300 to 40,900 pounds of static thrust at takeoff power settings. The CF6-50 engine typically develops 45,600 to 53,200 pounds of static thrust at takeoff power settings, and the CF6-80A engine typically develops 48,000 to 50,000 pounds of thrust at takeoff power settings. The CF6-80C2 engine configuration includes a thrust growth of 52,500 to 61,500 pounds of thrust at takeoff power. The CF6-80A and C2 engines are considered by GE to be a significant growth model of the engine, not just in thrust produced but in reliability enhancements.

The failure data base for the CF6 engine inventory covered the five year component trending period. This data base was comprised of 218 air carrier reported SDRs. Table 15 exhibits the types of failures reported.

The reported failures of controls and accessory items were significantly greater in number than the failures reported for other component categories. Thirty-nine percent of all reported failures involved controls and accessories. Of the control and accessory incidents reviewed, three items contributed to 76 percent of all reported failures: fuel controls, fuel pumps, and inlet gearboxes.

**TABLE 15. CPG ENGINE COMPONENT FAILURE INCIDENTS
FOR SELECTED CARRIERS**

COMPONENT	NUMBER OF INCIDENTS	TOTAL INCIDENTS
BEARINGS		11
#1 Bearing	4	
#2 Bearing	1	
#3 Bearing	2	
#4 Bearing	4	
AIRFOILS		56
Fan Blades	2	
5th Stage Compressor Blades	1	
6th Stage Compressor Blades	2	
7th Stage Variable Vane arm/pin	1	
8th Stage Compressor Blades	3	
9th Stage Compressor Blades	3	
Compressor Blades	4	
Variable Vanes	7	
1st Stage Turbine Blades	26	
2nd Stage Turbine Blades	3	
4th Stage Turbine Blades	1	
1st Stage Turbine Vanes	3	
CASES		7
Turbine Mid-Frame	5	
Compressor Rear Frame	2	
FUEL / OIL SYSTEMS		24
Oil Line	9	
Seals	3	
Fuel Filter	3	
Fuel Manifold	4	
Contained Fuel	1	
Fuel Line	2	
Fuel Nozzle	2	
CONTROLS AND ACCESSORIES		85
Fuel Control	19	
Fuel Control / Fuel Pump	26	
Fuel Pump	8	
CIT Sensor	8	
Engine Electronic Control	6	
Fuel / Oil Heat Exchanger	1	
Bleed Valve Connector	2	
Speed Sensor	1	
Inlet Gearbox	12	
Starter	2	
COMPRESSOR SECTION		9
14th Stage Bleed Air Duct	2	
Cross Over Duct	3	
Discharge Tube	2	
Fan Shaft	1	
5th Stage Disc	1	
COMBUSTION INNER LINER	1	1
TURBINE SECTION		6
HPT Disc	1	
Borescope Plugs Not Installed	1	
Turbine Shaft Bolts	2	
1st Stage Turbine Shroud	1	
Damage	1	
OTHER		19
Bird Strike	3	
Domestic Object Damage	2	
Unknown (Engine Replaced)	14	

As reported in the SDR, a fuel control failure produced an in-flight flameout, but the fuel control was generally not the only control or accessory replaced by maintenance personnel to resolve the problem. Of the 45 reported fuel control failures, 73 percent of the incidents replaced another accessory in addition to the fuel control. For these multiple removal incidents, 75 percent involved replacement of the fuel pump along with the fuel control. The impact of fuel control malfunctions was such that 69 percent of all fuel control incidents produced flameouts. Table 16 shows the fuel control malfunction impact upon the flight profile of the aircraft. Figure 8 shows the reported fuel control incidents per year over the five year component trending period. The number of fuel control incidents per year is basically constant with a high of nine incidents in 1989 and a low of four incidents in 1985.

TABLE 16. CF6 ENGINE FUEL CONTROL FAILURE INCIDENTS FOR SELECTED CARRIERS							
ENGINE OPERATIONAL CHARACTERISTICS	TAKE- OFF	CLIMB- OUT	CRUISE	DESCENT	APPROACH	AFTER LANDING	TOTAL
FLAMEOUT	2	2	7	12	4	4	31
SHUTDOWN	1	1	1		1		4
STALL/SHUTDOWN				1			1
POWER LOSS/RPM ROLLBACK	2		1	1			4
THROTTLE MOVEMENT/SETTING				1			1
POWER SURGES		2	1				3
FUEL FILTER CLOG LIGHT			1				1
	5	5	11	15	5	4	45

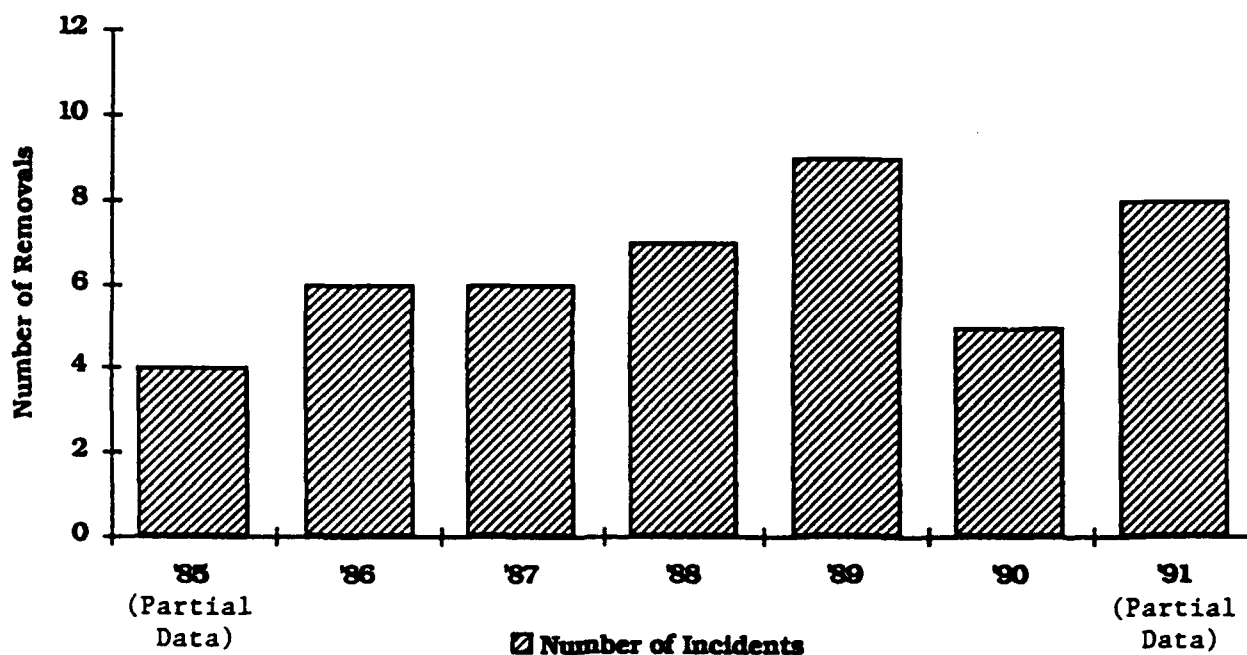


FIGURE 8. CF6 ENGINE FUEL CONTROL INCIDENTS BY YEAR FOR SELECTED CARRIERS

The CF6 engine fuel pump failures also impacted engine operation. Of the 34 reported failed fuel pumps, 77 percent involved the removal of other accessories with 76 percent of the multiple removals involving the fuel control. Similar to the fuel control in the impact on the flight profile, 74 percent of all fuel pump incidents resulted in an engine flameout. Table 17 shows the fuel pump malfunction affect upon the flight profile of the aircraft. Figure 9 shows the reported fuel pump incidents per year over the six year period trended. Very similar to the fuel control plot, the number of fuel pumps incidents per year is basically constant with a high of eight incidents in 1989 and a low of three incidents in 1985.

TABLE 17. CF6 ENGINE FUEL PUMP FAILURE INCIDENTS FOR SELECTED CARRIERS							
ENGINE OPERATIONAL CHARACTERISTICS	TAKE- OFF	CLIMB- OUT	CRUISE	DESCENT	APPROACH	AFTER LANDING	TOTAL
FLAMEOUT	3	2	8	5	3	4	25
SHUTDOWN			3				3
POWER LOSS/ RPM ROLLBACK			3	1			4
THROTTLE MOVEMENT/SETTING			1				1
FUEL FILTER CLOG LIGHT			1				1
	3	2	16	6	3	4	34

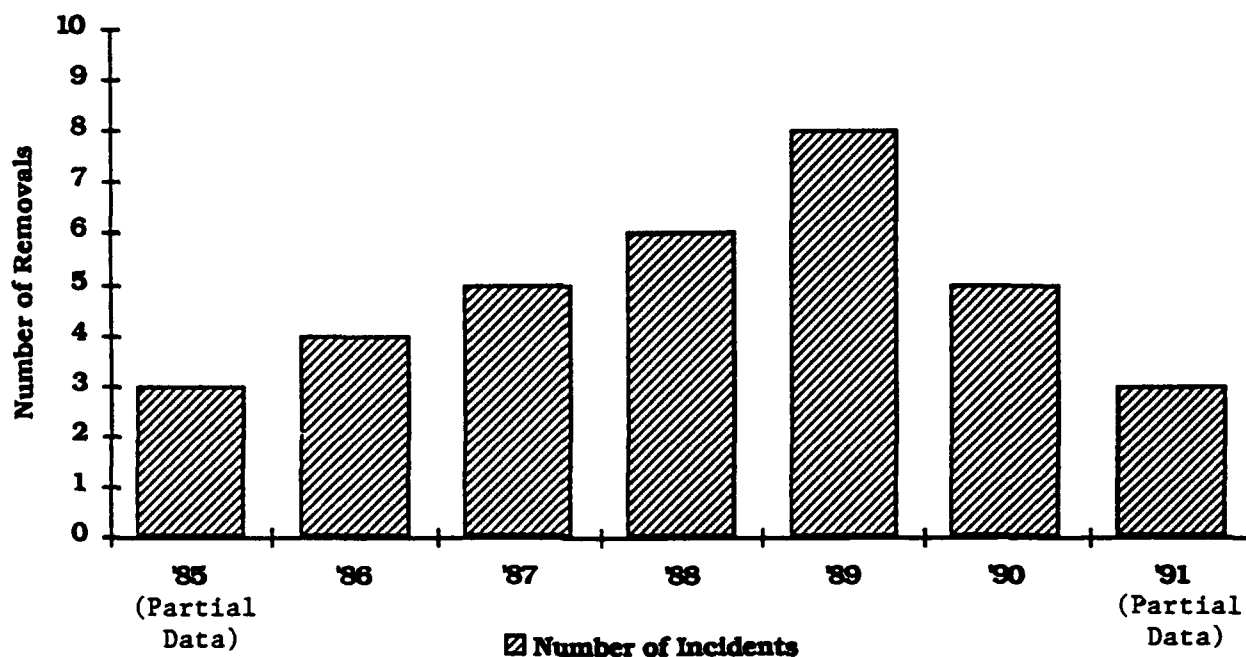


FIGURE 9. CF6 ENGINE FUEL PUMP FAILURE INCIDENTS BY YEAR FOR SELECTED CARRIERS

The dual removal of both the fuel pump and fuel control by line maintenance personnel is intended to resolve a reported in-flight engine flameout. Although GE has provided the air carriers with diagnostic

trouble-shooting information, the air carrier maintenance concept to perform dual or multiple pulls continues to ensure the engine is completely repaired. In addition, the CF6-6 and CF6-50 engines are designed such that the fuel control and fuel pump are mounted piggyback. The piggyback mount design makes it convenient for maintenance personnel to perform dual removals of the fuel control and fuel pump. The CF6-80 series engine has the fuel control and the fuel pump on opposite sides of the engine. The physical separation of the fuel pump and fuel control plus reliability enhancements to each unit has significantly reduced the incidents of dual accessory removal for the CF6-80 series engine.

There were twelve reported incidents of CF6 engine inlet gearbox failures. The two most notable gearbox failure trends were failure of the radial bevel gear and failure of the bevel gear shaft. Eleven of the twelve reported inlet gearbox failures occurred on the CF6-6 engine inventory with the remaining failure having occurred on a CF6-50 engine. The CF6-6 engine model had employed a black oxide coating on the inlet gearbox bevel gears and the shaft for corrosion protection and improvement in the retention of a lubricating film. The inlet gearbox bevel gear and shaft are highly stressed parts and the application procedure for the black oxide coating created a corrosive environment, often leading to stress corrosion cracking in subsequent flight operation. The use of black oxide coating has been discontinued.

Of the 218 reported failures, 26 percent involved airfoil components, with the largest percentage of the airfoil failures (46 percent) involving first stage turbine blades. Approximately half of the reported first stage turbine blade failures were installed on the CF6-6 engine inventory. The CF6 engine configuration does not have the DS turbine blade as its standard bill of material. The later growth models of the CF6 engines, such as the CF6-80 series, incorporate the DS turbine blades and only four incidents of first stage turbine blade failures were reported on the CF6-80 engine series. The DS material turbine blade is providing improved reliability.

There was a definite trend of TMF case failures. The CF6-6 and -50 engine TMF cases are made of Inconel 718 material using a Tungsten Inert Gas (TIG) weld fabrication process. The TMF case has an approximate 0.04 inch thick plasma sprayed thermal barrier coating on the inside surface. This coating limits the sensitivity of the currently approved inspection procedure. The objective is to develop an inspection procedure for cracks in the heat affected zone of weld areas, cracks under the thermal barrier coating and cracks in the circumferential welds around the case bosses. Samples were provided by GE to evaluate the ability of the UI-IV™ system to satisfy this inspection requirement. The preliminary results of that evaluation are documented later in this report.

There were only two failures reported on the CF6-80A engine CRF case. However, due to the severity of the failure that occurs when a CRF cracks, this item has been previously identified as requiring an enhanced inspection procedure. The CRF is made of cast Inconel 718 material that is difficult to inspect due to the large grain micro structure. GE has an eddy current (EC) procedure used to inspect cracks in the mid flange scallop area. Ultrasonic inspection of this area has proven difficult due to the large grain size. GE provided a CRF sample that contained an EDM notch to be used for inspection system sensitivity checks and preliminary validation of an ultrasonic inspection procedure. The UI-IV™ system identified the EDM notch dimensions and those results are identified later in this report.

PT6 ENGINE COMPONENT FAILURE ANALYSIS

The PT6 engines reviewed in this study were installed on six different airframes which included the Beech 99, Beech 1900, Empresa Brasileira de Aeronautica 110, deHavilland DHC6 and DJC7, and Short Brothers 330 aircraft. Over 108 air carriers and airframe/engine combinations were reviewed and the component failure incidents on 24 PT6/airframe combinations were recorded and trended. These air carriers operated an average of 1416 PT6 engines per month.

The PT6 engine represents 1960's technology and has performed reliably in numerous applications for 30 years. Of the various PT6 engine models reviewed, the PT6A-27 on the deHavilland Twin Otter airframe had the lowest rated takeoff horsepower at 680 foot pounds (torque), while the PT6-45R engine on the Short Brothers 330 had the highest rated takeoff shaft horsepower at 1196 foot-pounds (torque).

The failure data base for the PT6 engine inventory covered the five year period from 1986 to 1991. This data base was comprised of 410 reported SDRs. Table 18 exhibits the types of failures reported.

The greatest number of engine shutdowns occurred during takeoff. Approximately 30 percent of all reported SDRs involved aborted takeoffs, normally as the engine failed to meet the required takeoff torque. The dominant cause for the aborted takeoff was control and accessory failures. Control and accessory failures were also responsible for 60 percent of all the SDR reported failures. The most significant failure trends were recorded by fuel controls, bleed valves and fuel pumps.

TABLE 18. PT6 ENGINE COMPONENT INCIDENTS FOR SELECTED CARRIERS		
COMPONENT	NUMBER OF INCIDENTS	TOTAL INCIDENTS
BEARINGS		32
#1 Bearing	4	
#2 Bearing	3	
#3 Bearing	4	
#4 Bearing	5	
Other Bearings/Gears/Couplings	11	
1st Stage Planetary Gear	2	
Garloc Seals	3	
AIRFOILS		35
C-T Blades	12	
Turbine Vanes	4	
Power Section	10	
Gas Generator Section	6	
C-T Section	3	
REPLACED ENGINE		23
BIRD STRIKE / FOD / DOD		5
PROPELLER		2
CONTROLS AND ACCESSORIES		248
Fuel Control	124	
Fuel Pump	18	
Bleed Valve	59	
Power Lever	4	
Fuel Topping Governor	8	
Overspeed Governor	5	
Torque Transmitter	4	
T-5 Indicator / Harness	6	
Fuel - Oil Heater	3	
Tach Generator	1	
Oil Pump	2	
Oil Pressure Relief Valve	14	
FUEL / OIL SYSTEM		65
PY Line	13	
P3 Line	23	
P4 Line	1	
Fuel Line	5	
Fuel Nozzle	1	
Flow Divider	3	
Oil Filter	10	
Oil Cap Loose	9	

Approximately 46 percent of the fuel control incidents were corrected by adjustment of the Gas Generator (NG) stop. The remaining 54 percent of the incidents were corrected by removal and replacement of the fuel control. The NG stop is adjusted to release additional fuel from the fuel control to the NG to compensate for a deteriorating hot section. The more fuel the fuel control releases, the higher the exhaust gas temperature (EGT) becomes. Eventually, the EGT exceeds the operational limits before minimum takeoff torque is reached, causing an aborted takeoff. Malfunctioning fuel controls were the most frequent reason for the PT6 engine failing to meet takeoff thrust. Fuel controls also frequently produce power surges and power loss while in cruise as can be seen from table 19. Figure 10 shows the reported fuel control incidents over the five year period. The greatest number of fuel control adjustments during the five year period occurred in 1987 when over 59 percent of all fuel control reported incidents required adjustment rather than replacement. Adjustment of the NG stop as well as linking arms and rods were the most frequently accomplished maintenance tasks of the fuel control. A Service Bulletin was issued on the

Woodward fuel control changing the contact end of the compressor discharge bellows rod from round to a more square surface, thus enhancing the opportunity for a positive contact of mating surfaces.

TABLE 19. PT6 ENGINE FUEL CONTROL FAILURE INCIDENTS FOR SELECTED CARRIERS							
ENGINE OPERATIONAL CHARACTERISTICS	TAKE- OFF	CLIMB- OUT	CRUISE	DESCENT	APPROACH	AFTER LANDING	TOTAL
FAILED TO MEET TORQUE REQUIREMENT	68						68
FLAMEOUT					1		1
SHUTDOWN	2	1	4			1	8
POWER LOSS/RPM ROLLBACK		4	12	1	3	2	22
POWER SURGES	2	2	13	2		1	20
POWER LEVER MOVEMENT			1	1		1	3
FUEL LEAK	2						2
	74	7	30	4	4	5	124

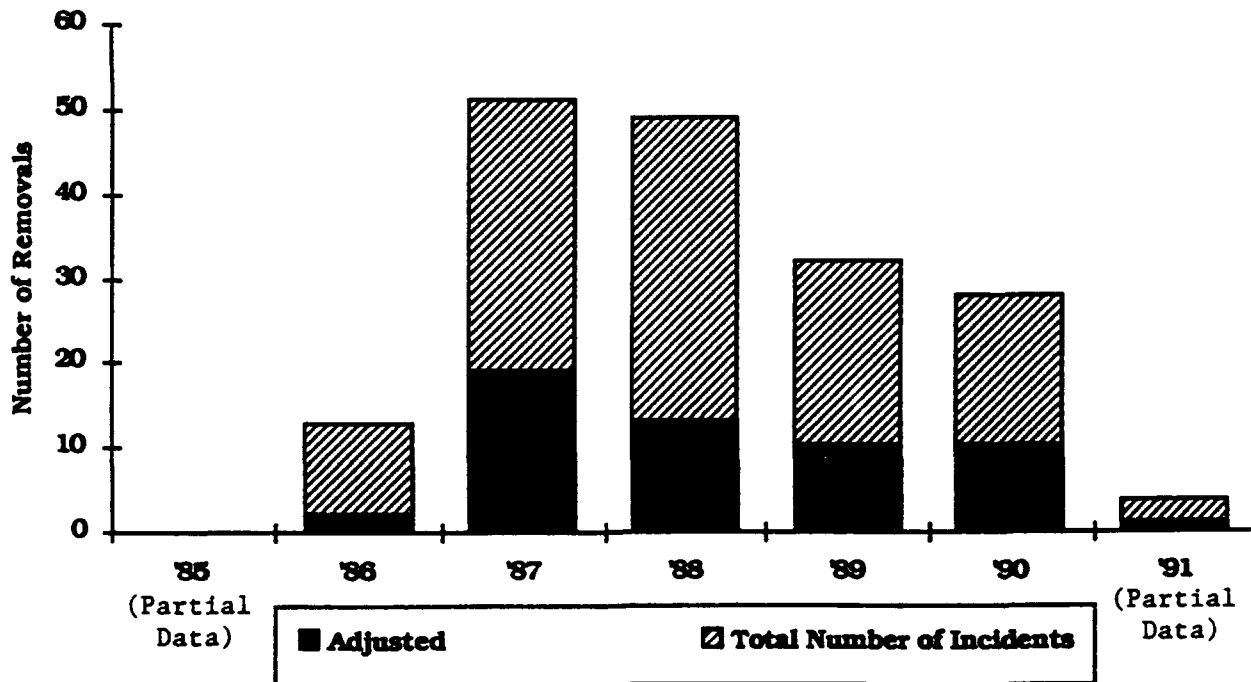


FIGURE 10. PT6 ENGINE REPORTED FUEL CONTROL INCIDENTS BY YEAR, FOR SELECTED CARRIERS

The second largest number of control and accessory reported failure incidents occurred on bleed valves. Of the 59 reported incidents, nineteen occurred during 1990 as shown in figure 11. Bleed valve failure modes included ruptured diaphragms, scored or missing valve seats and a few incidents of improper bleed valve installation. Bleed valves are extremely sensitive to maintenance repair actions. A

configuration upgrade to incorporate a piston operated valve in lieu of the original diaphragm operated valve is now available and greatly increases the reliability of the bleed valve accessory. As shown in table 20, a malfunctioning bleed valve either causes the PT6 engine to not meet the required takeoff torque and abort takeoff or causes a compressor stall while in cruise.

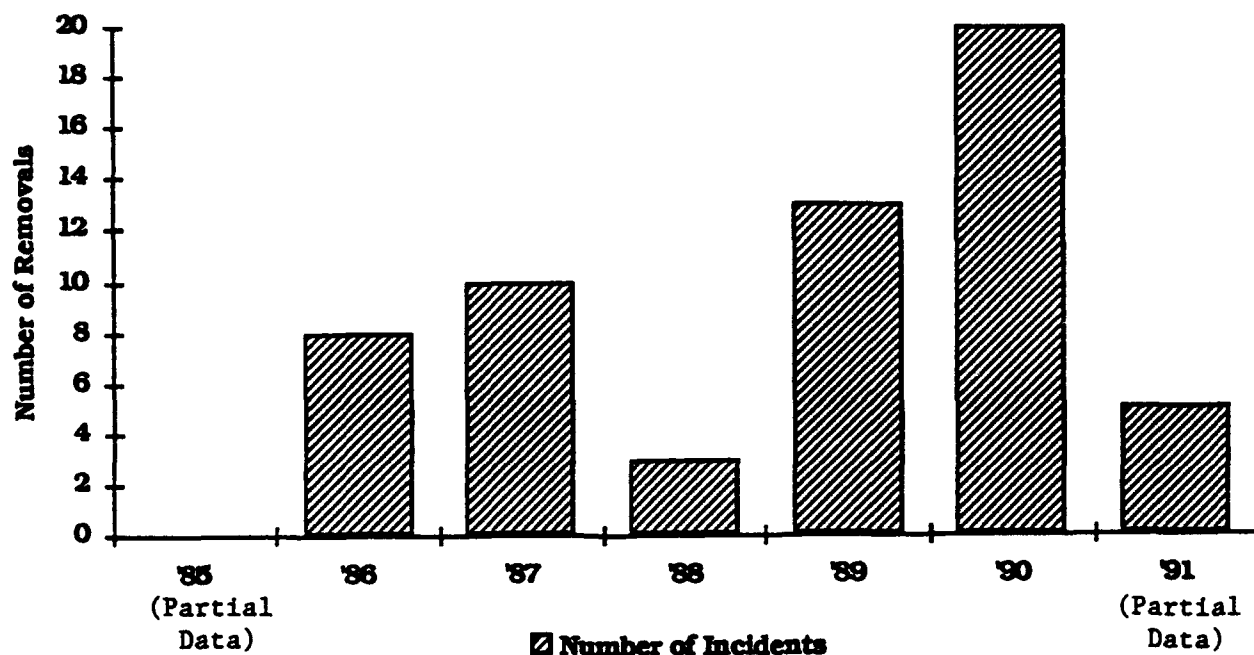


FIGURE 11. PT6 BLEED VALVE FAILURE INCIDENTS BY YEAR FOR SELECTED CARRIERS

TABLE 20. PT6 ENGINE BLEED VALVE FAILURE INCIDENTS FOR SELECTED CARRIERS						
ENGINE OPERATIONAL CHARACTERISTICS	TAKE-OFF	CLIMB-OUT	CRUISE	DESCENT	AFTER APPROACH	LANDING TOTAL
FAILED TO MEET TORQUE REQUIREMENT	20	3				23
COMPRESSOR STALL	3	1	6	4	2	16
SHUTDOWN			4		1	5
POWER LOSS/RPM ROLLBACK		4	4			8
POWER SURGES	5		2			7
	28	8	16	4	3	59

The third largest number of control and accessory reported failure incidents occurred on the fuel pump. During the five year period, eighteen fuel pump failure incidents were reported. The greatest number of failure incidents were reported in 1989 as shown in figure 12. The two most frequently reported failure modes for the fuel pump included sheared drive shaft and worn/stripped splines on the drive shaft. The spline wear and drive shaft failures are caused by loss of lubrication inside the fuel pump.

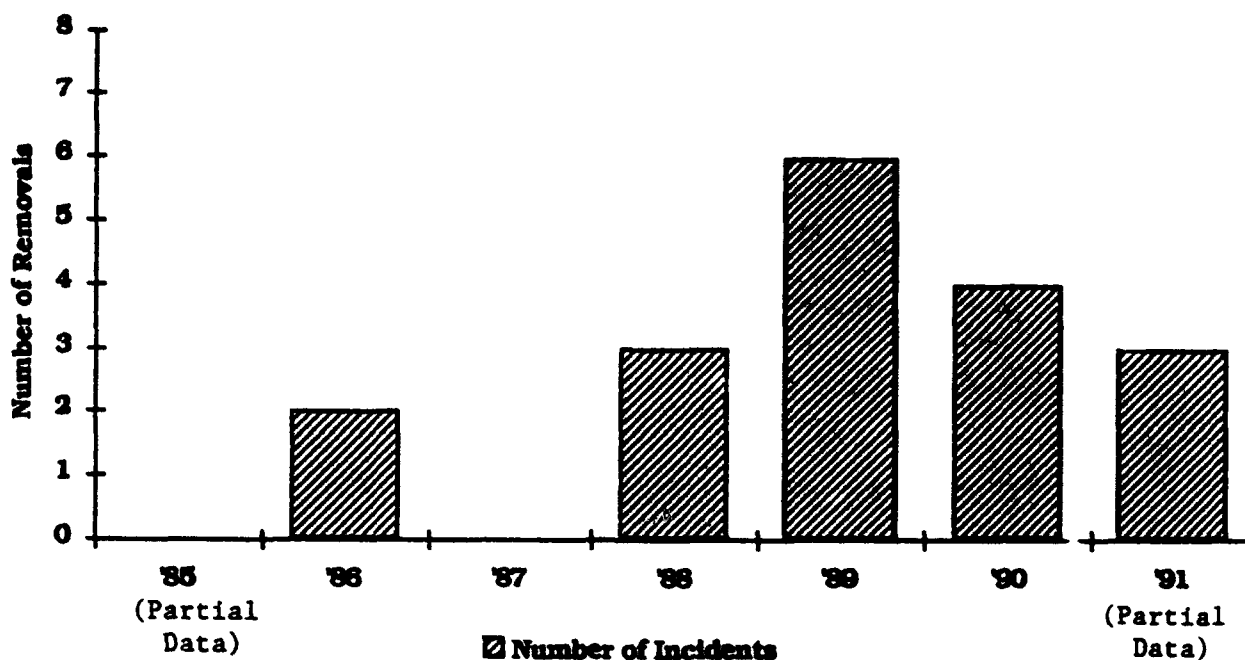


FIGURE 12. PT6 FUEL PUMP REMOVALS, BY YEAR
FOR SELECTED CARRIERS

The PT6 engine is designed with the fuel control mounted piggyback to the fuel pump. Line maintenance is required to perform a fuel leak check at the bearing drain cavity where the two controls are connected. If a leak is detected, both the fuel pump and fuel control must be removed and replaced. Once the seal connecting the two accessories begins to leak, a typical failure is bearing seizure on both controls. A redesign of the fuel pump shaft should be considered to reduce spline wear and the incidents of sheared shaft. Table 21 shows the impact fuel pump failures had upon aircraft operation. Failed fuel pumps often produced power losses or surges while in cruise rather than causing aborted takeoffs.

TABLE 21. PT6 ENGINE FUEL PUMP FAILURE INCIDENTS FOR SELECTED CARRIERS						
ENGINE OPERATIONAL CHARACTERISTICS	TAKE- OFF	CLIMB OUT	CRUISE	DESCENT	AFTER APPROACH LANDING	TOTAL
FAILED TO MEET TORQUE REQUIREMENT						--
FLAMEOUT			1		1	2
SHUTDOWN			1		1	2
POWER LOSS/RPM ROLLBACK		2	5	2		9
POWER SURGES			2			2
FUEL LEAK	3					3
	3	2	9	2	2	18

The data base created for the PT6 engine component failure analysis also permits review of reported failure history by engine serial number. These reviews can be useful in tracking specific serial numbered engines for maintenance and trouble shooting deficiencies. Table 22 provides data on two separate engines with fuel control problems. Initial adjustments of the fuel control were insufficient to produce the required takeoff torque. The fuel control was eventually replaced within 45 to 60 days of the initially reported incident.

TABLE 22. PT6 ENGINE TROUBLE SHOOTING			
A/C TYPE	ENGINE S/N	DATES OF REPORTED INCIDENTS	
		8/4/87	11/23/87
EMB 110	XXXXX		
TAKEOFF ABORTED		Y	Y
FAILED TO MEET T/O TORQUE		Y	Y
FLAMEOUT		N	N
SHUTDOWN		N	N
FAILURE ITEM REPORTED		FUEL CONTROL	FUEL CONTROL
REPLACED		Y	--
ADJUSTED		--	Y
EMB 110	YYYYY	5/17/88	7/7/88
TAKEOFF ABORTED		Y	Y
FAILED TO MEET T/O TORQUE		Y	Y
FLAMEOUT		N	N
SHUTDOWN		N	N
FAILURE ITEM REPORTED		FUEL CONTROL	FUEL CONTROL
REPLACED		N	Y
ADJUSTED		Y	N

JT9D ENGINE CASE FAILURE ANALYSIS

Review of the JT9D engine component failures documented in the FAA SDR data base from 1986 through the end of 1991 identified thirteen engine case failures; six fan case failures, five diffuser case failures, one outer combustor case failure, and one intermediate case failure.

None of the fan case failures were of a catastrophic nature. Five of the six fan cases were removed from service due to excessive vibration or in-flight compressor stall. The most common cause of failure was excessive fan blade tip clearance exceedance. These excessive clearances were produced by fan blade shingling and gouges in the fan case rub strip areas. The abradable seal in the fan case slot would tear away causing some downstream FOD. As a result, engine vibration or a compressor stall would occur.

Three of the five diffuser case failures occurred when internal struts collapsed at the strut to case weld allowing hot air to enter the number three bearing cavity. This increased pressure would eventually cause the breather elbows to fail and occasionally produce oil vapors that would catch fire. The other two diffuser case failures occurred from ruptures and cracks in the 6 o'clock position on the diffuser case. Both incidents originated from a weld repair.

The one recorded incident of an outer combustor case failure produced a catastrophic failure that caused the pilot to abort take-off which resulted in a fire that burned for more than ten minutes. The outer combustor case had a wall/flange rupture which the rear flange mates to the turbine case, resulting in the attach bolts shearing.

The one recorded incident of an intermediate case failure initiated in the heat affected zone of a weld from a previous repair at the 12 o'clock position. The crack produced an oil leak in the case.

There were several incidents where case failures emanated from the weld zones of previous repair and original fabrication welds. The current inspection procedure is not sufficiently sensitive to detect small flaws in repair welds. SAIC, using the UI-IV™ system, has demonstrated the ability to characterize weld

zones around boss welds and previous repair welds to assure the structural integrity of the welds. The preliminary procedures and results for weld characterizations on the JT9D diffuser case are outlined in the following section.

JT9D DIFFUSER CASE NDI DEVELOPMENT

The JT9D-7A series diffuser case is experiencing a failure mode in the stiffener rail. PWA has developed an on-wing EC inspection procedure to detect cracks along the diffuser case stiffener rail. When a crack indication occurs on the stiffener rail during an on-wing inspection, the engine is required to be reinspected within certain cycles depending on the indicated crack size. If the crack indication runs from the stiffener rail to the diffuser case or is longer than 1.25 inches but less than 2 inches, the engine is required to be removed within 25 cycles in order to weld repair the crack. If the crack indication exceeds 2 inches in length, the engine is required to be removed immediately in order to weld repair the crack. Weld repairs of cracks are inspected in the shop before the diffuser case is released back into service. However, cracks in the weld repair region have been found shortly after performing the weld repair. It is a very difficult task to detect and identify small cracks hiding behind the coarse grain structure of the weld repair material. This is especially true for the conventional ultrasonic testing method where A-scans result in different signal-to-noise ratios at different locations. The problem is to reliably detect small cracks behind the weld where background noise occurs due to the grain structure mixed with ultrasonic signals caused by the crack.

Various approaches have been attempted by SAIC to solve the problem including signal and noise spectrum analysis, adapted learning algorithms, and the feature analysis method. The SAIC approach included using the imaging equipment in conjunction with transducer frequency optimization, signal processing and filtering prior to image display. The final approach, chosen by SAIC, was an ultrasonic imaging technique which uses an angle beam.

The basic principle of ultrasonic imaging is to record relevant ultrasonic signals which have been transmitted through the material. Due to refraction, reflection, diffraction, scattering and interference of the sound beam on grain boundaries, true characterization of ultrasonic signals from different size cracks at different locations requires sophisticated equipment and extensive testing and analysis. The process of conducting ultrasonic tests involves optimization of transducer parameters, frequencies and size. Other factors include beam diameter, near and far field, beam angle, beam spread, crack size, crack orientation and crack location. To correlate measured signals with actual crack locations, an encoder or encoded scanner is required. PWA provided two JT9D diffuser case samples to SAIC in order to conduct the tests and perform the analysis required to develop a preliminary ultrasonic inspection procedure for crack detection inside a weld repair. Included as part of the preliminary inspection procedure, SAIC developed a computer controlled motorized (automated) scanner for the JT9D outer combustor diffuser case.

The first sample from PWA was approximately 5 inches wide by 7 inches long with a crack in the middle of the weld repair section in the stiffener rail. Figure 13 is a picture of the JT9D diffuser case identified as Sample 1. Figure 14 is a sketch of Sample 1 annotating the surface identification. The stiffener rail is located on the outer diameter of the top surface of the diffuser case. Based on the configuration of the diffuser case, figure 15 indicates all the possible scanning directions. The typical crack required to be detected is a small crack in the stiffener rail behind the large grain structures in the weld repair as sketched in figure 16. Shear wave angle beam tests have been conducted with transducers scanning surface A, surface D and surface E.

Two representative tests conducted by SAIC using a transducer scanning inner surface E of Sample 1 are identified as Test 45D5M2G and Test 5MQTR60. Figure 17 shows the UI-IV™ C-scan results of Test 45D5M2G with a X-Y image resolution of 1mm. A 5 MHz shear wave angle beam transducer with a 45-degree refraction angle to direct the beam normal to the stiffener rail was used to obtain the results for Test 45D5M2G. The stiffener rail and the crack are clear images as annotated by the arrows in figure 17. Figure 18 shows the UI-IV™ C-scan results of Test 5MQTR60. A 5 MHz shear wave angle beam transducer with a 60-degree refraction angle to direct the beam normal to the stiffener rail was used to obtain the results for Test 5MQTR60. In both tests, the sound path passed through the welds before reaching the crack.

Two additional tests were performed with the transducer scanning the top surface of Sample 1. Test 5MREJSK was performed scanning surface D using a 5 MHz 60 degree angle beam transducer. The beam direction was normal to and toward the stiffener rail. The skip path signal with a reject level threshold was used to eliminate background noise. Ultrasonic imaging results are shown in figure 19. Test 5MREJSK identifies the stiffener rail and the crack in the middle of the stiffener rail. Test FAAT2 was conducted similarly to Test 5MREJSK except the transducer was placed on surface A. The beam direction

is normal to and toward the stiffener rail. UI-IV™ C-scan results are shown in figure 20 and identifies the stiffener rail and the crack in the middle of the stiffener rail.

After completing ultrasonic tests of Sample 1, PWA supplied a larger sample of the JT9D outer combustor diffuser case which measured 12 inches wide by 17 inches high. Figure 21 is a picture of the JT9D diffuser case identified as Sample 2. A 20 mil deep saw cut was introduced in the stiffener rail, as shown in figure 22. Figure 22 shows the configuration of both the outside and inside views. Due to the numerous obstructions on the outer diameter surface of the diffuser case, transducer placement is not possible on the outside surface of the diffuser case. Surface E, the inner diameter surface, is accessible except for the vane areas. All tests on Sample 2 were conducted from the inner diameter surface.

Three representative tests conducted by SAIC which used a transducer scanned from the inner diameter surface of Sample 2 are identified as Test L15DNOMC, Test PYCRKSAM and Test NYCRKSAM. UI-IV™ results of Test L15DNOMC are shown in figure 23. This test used a 15 MHz longitudinal wave transducer with a delay line scanned in a circumferential direction. The ultrasonic gate was set to the nominal thickness of the diffuser case. Ultrasonic results clearly show the image of the stiffener rail and other contour patterns of the outer diameter surface.

Figures 24 and 25 show the UI-IV™ results of Test PYCRKSAM and Test NYCRKSAM respectively. These tests used a shear wave angle beam transducer with the beam directed toward the positive and negative circumference direction along the stiffener rail. The recorded signals were reflected from the 20 mil saw cut on the stiffener rail. Image results of the same saw cut in the two tests showed the crack at two different locations relative to the transducer clockwise coordinates. For accurate ultrasonic imaging results, both the signals and locations of the transducer must be accurate. Therefore, the computer controlled motorized encoded scanner adapted for the JT9D outer diffuser case configuration was developed.

The encoded scanner is made up of a motor, encoder system and motion controller. A schematic of the encoded scanner control is shown in figure 26. The scanner is driven by two small 4 watt DC motors. The scanner position is maintained by the attached encoders. The gear ratios for driving the assembly are 500:1 and 50:1 for the track and arm axes. Figure 27 is a sketch of the motorized scanner. The track axis is located in the circumferential direction around the inner diameter surface of the diffuser case. The arm axis is along the longitudinal direction of the diffuser case as shown in figure 28. Figure 29 is a sketch of the motorized scanner in relation to Sample 2. Figure 30 presents photograph of the motorized scanner set-up to perform scans on Sample 2.

Prior to starting the computer controlled scanner, the ultrasonic imaging system and the ultrasonic angle beam signals must be set for data collection. Standard operating procedures are developed for each ultrasonic imaging inspection system. The description of the UI-IV™ and set up procedure is shown in Appendix C. To establish the ultrasonic settings a B-scan was run for Sample 2 and recorded as Test BSC2PYCK with the transducer beam directed along the circumferential direction of the stiffener rail. A 5MHz, 45 degree, 0.25 inch diameter transducer was used. Figure 31 shows the results of Test BSC2PYCK where an A-scan of the ultrasonic signal from the 20 mil saw cut on the stiffener rail is displayed.

The operation procedures of the computer controlled scanner are described below:

- 1: Put program disk in the motion controller processor; manual selections will appear on the screen.
- 2 Use JOG command and arrow keys to move the transducer to any designated home location/position.
- 3 Enter scanning parameters, i.e. scanner speed and acceleration, length of scanning direction and increment direction.
- 4 Press SCAN to start scan; the transducer will move from home position to scan along the X-direction and increment in the Y-direction. When the entire area is scanned, the scanner will return to the home position and stop automatically.

The computer controlled motorized scanner was used to perform the Test SANDIA-7. The UI-IV™ results of Test SANDIA-7 are shown in figure 32. Test SANDIA-7 recorded the 20 mil saw cut in the stiffener rail as annotated by the arrows. The C-scan image is shown in the top of the figure and an amplitude profile plot is shown at the bottom of the figure for the intersecting line shown in the C-scan. The preliminary inspection procedures for the JT9D diffuser case are outlined in Appendix D.

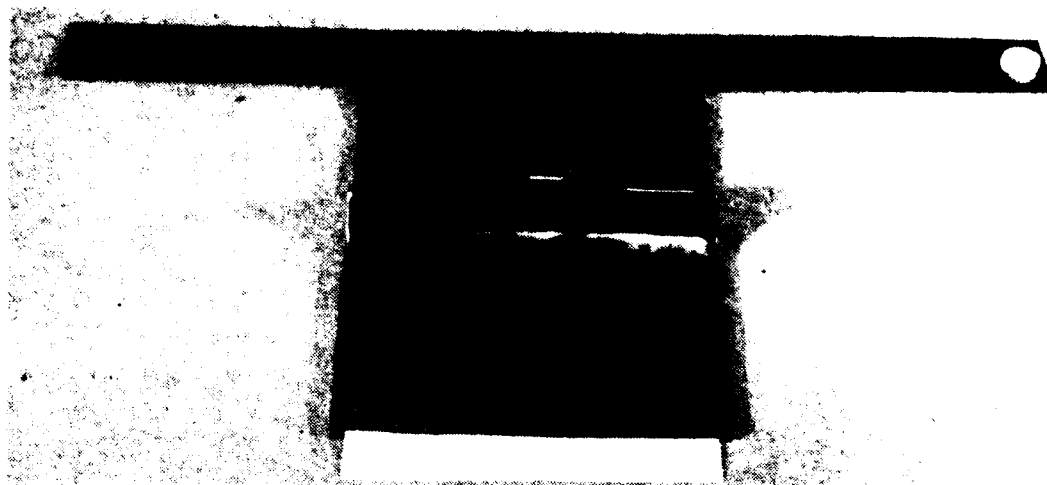
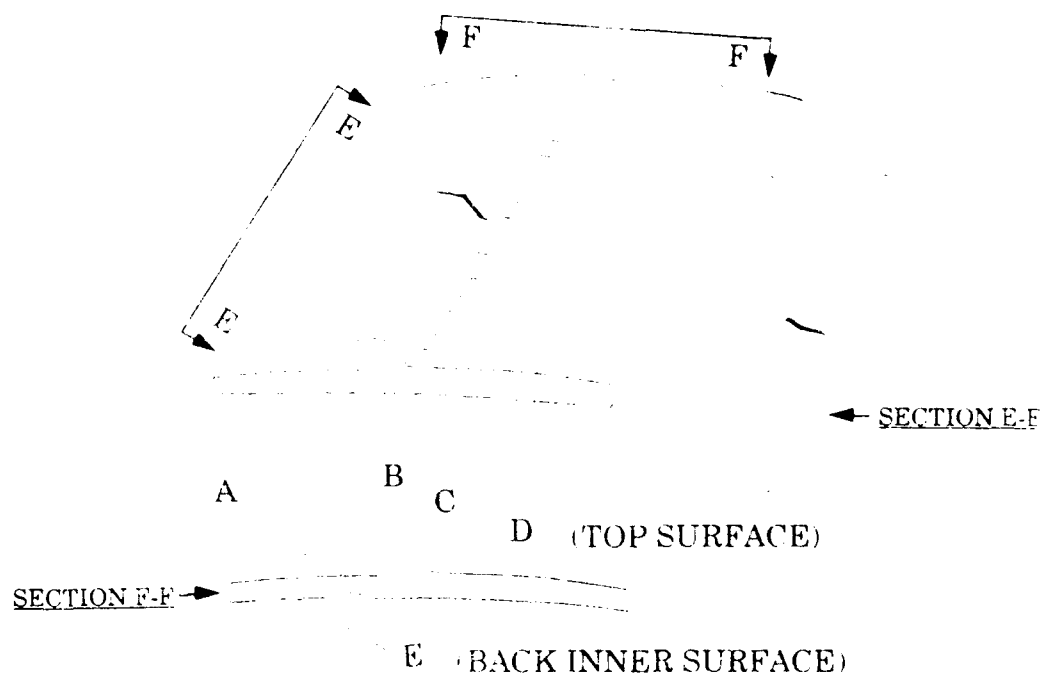
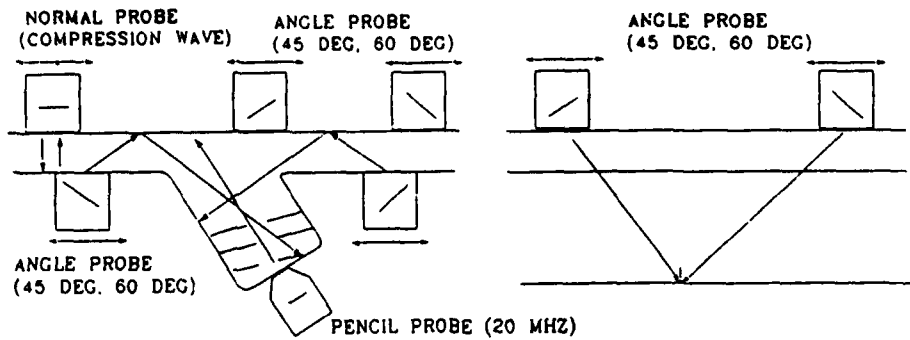


Figure 13. JT9D Outer Combustor Diffuser - Sample 1



JT9D SAMPLE 1 INSPECTION SURFACES

Figure 14. JT9D Outer Combustor Diffuser



**Figure 15. JT9D - Sample 1 Possible Angle Beam Directions
Through Weld Repair Of Service Induced Crack**

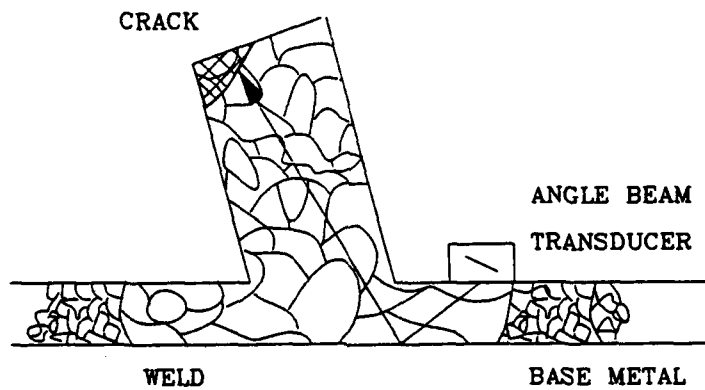


Figure 16. JT9D - Sample 1 Angle Beam Through Weld Repair Material Of Crack

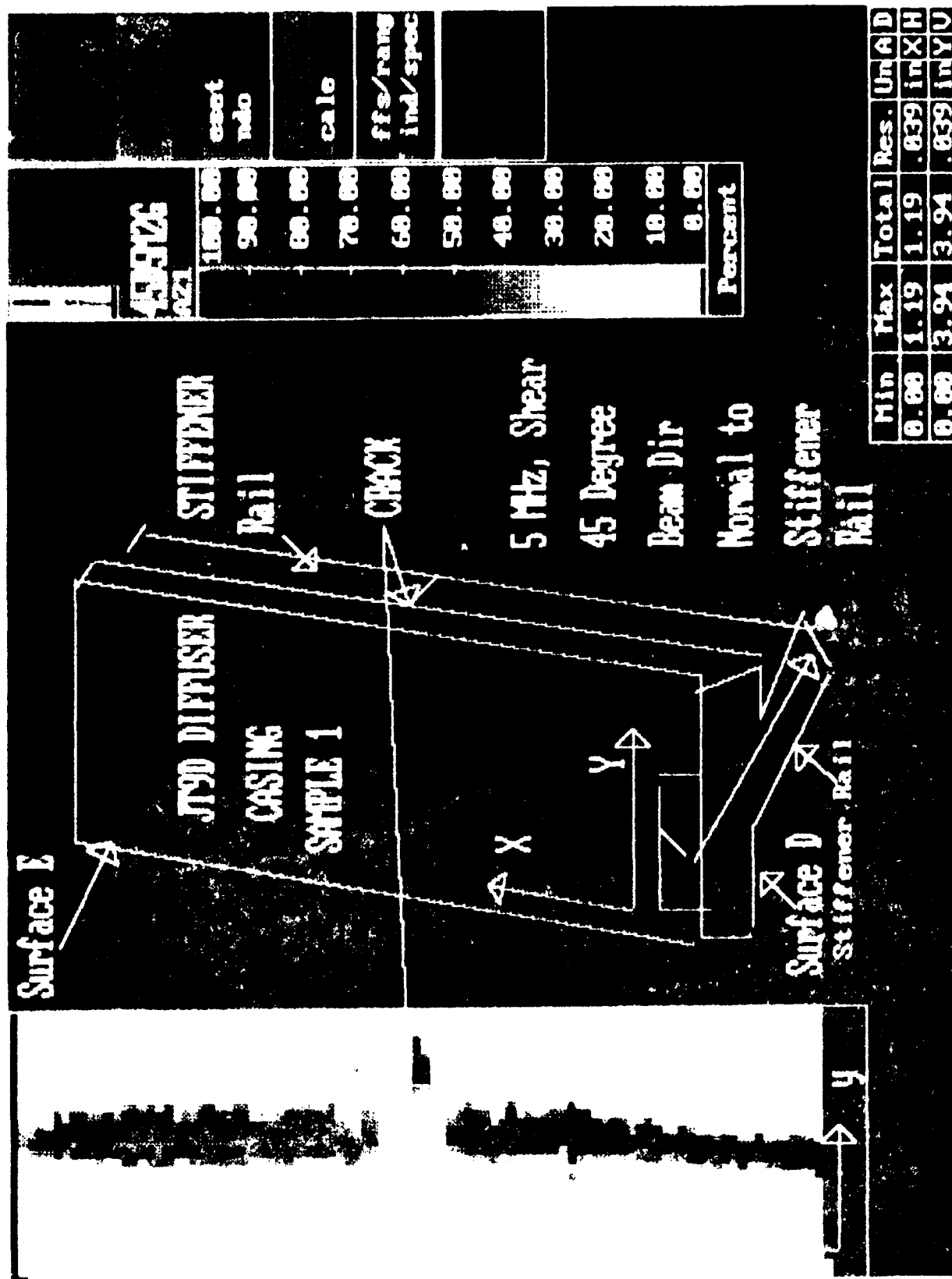
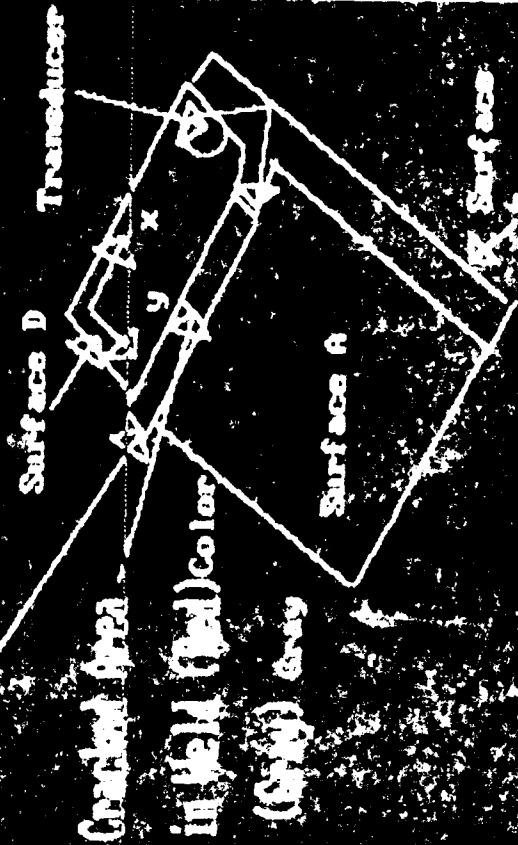


Figure 17 Ultra Image 12.4 45D5M2G, Shear Wave Scanning From Inner Surface, E

JT90 SAMPLE 1 : TRANSDUCER ON SURFACE D

JT90 Diffuser Stiffener Rail (Blue) Color
(Black) Grey



JT90 Diffuser Weld Sample Tested with

U-14 Standard Angle Beam 5 MHz, 1/4"

60 Deg (Top Surface) - D

Pos	Min	Max	Total	Res.	Unit
1.13	0.00	1.83	1.83	.839	inXH
2.63	0.00	6.61	6.61	.839	inYU

UNIT

0.1

100.00	color
50.00	area
80.00	circle
70.00	line
60.00	rectangle
50.00	high
40.00	normal
30.00	del
20.00	rise all
10.00	save
0.00	hide
0.00	cancel
0.00	hide
0.00	pick
0.00	inc

UNIT

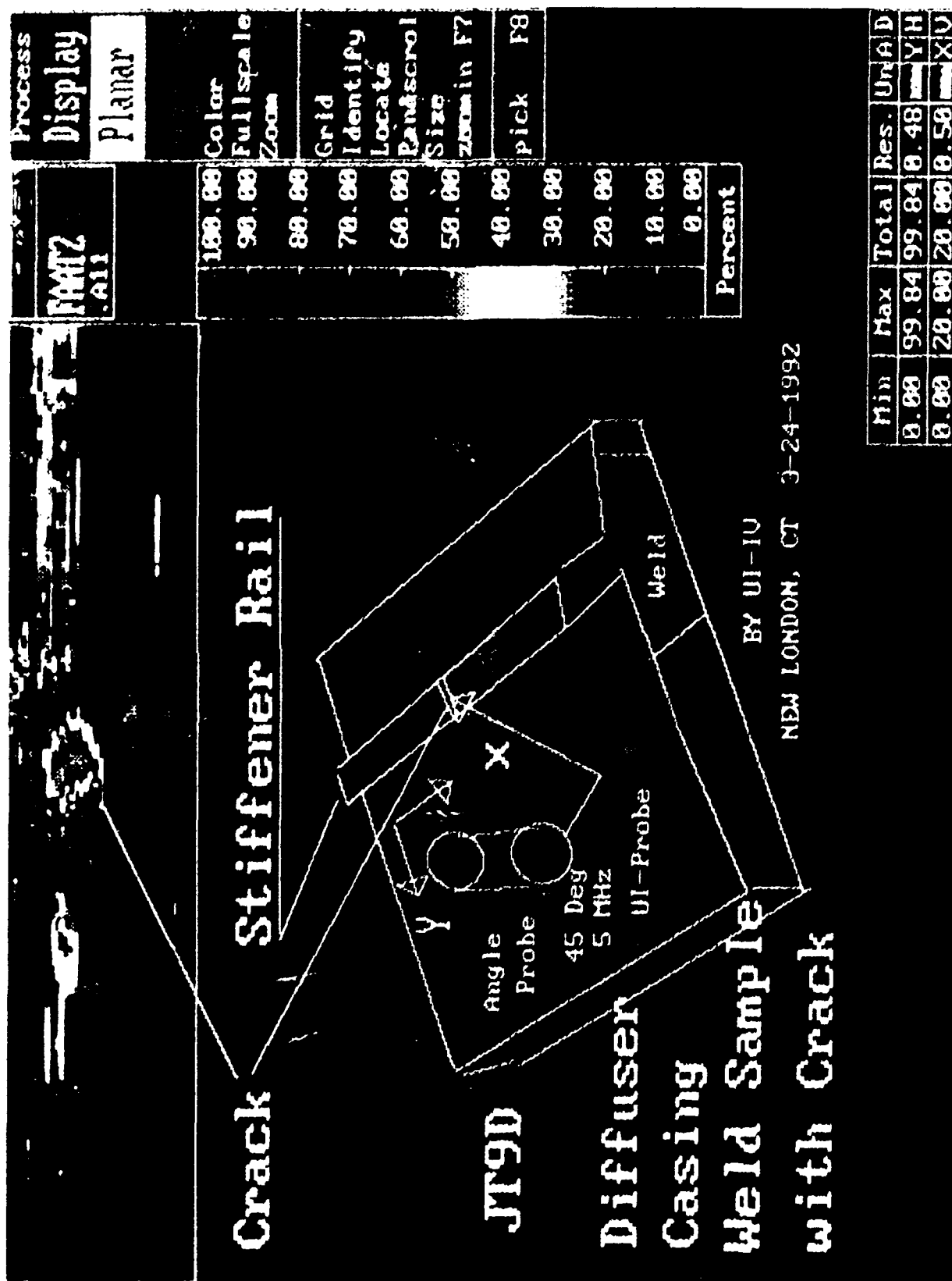


Figure 2C. Ultra Image Test FAAT2, Shear Wave, Sample 1, Scanning From Outer Surface, A

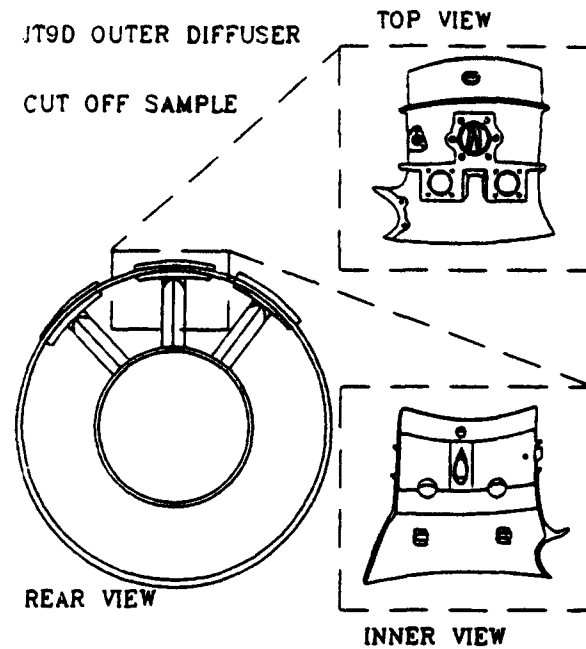


Figure 21. JT9D Outer Combustor Diffuser - Sample 2

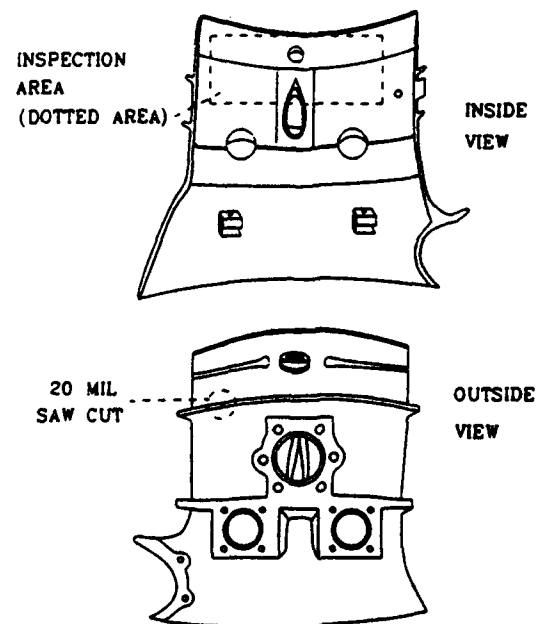


Figure 22. JT9D - Sample 2 with 20 mil Saw Cut

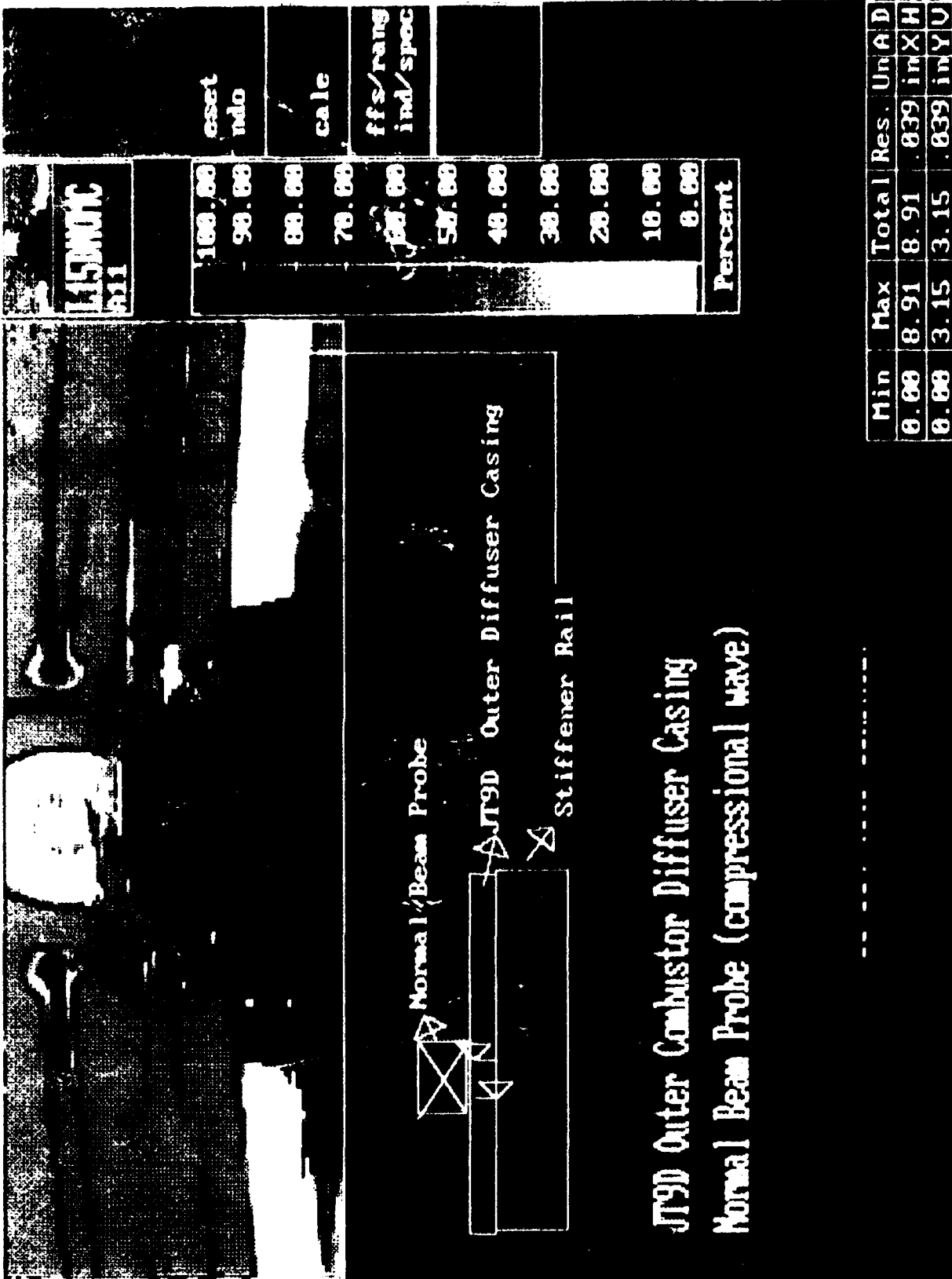


Figure 23. Ultra Image Test L15DNOMC, Compression Wave, Sample 2, Scanning From Inner Surface

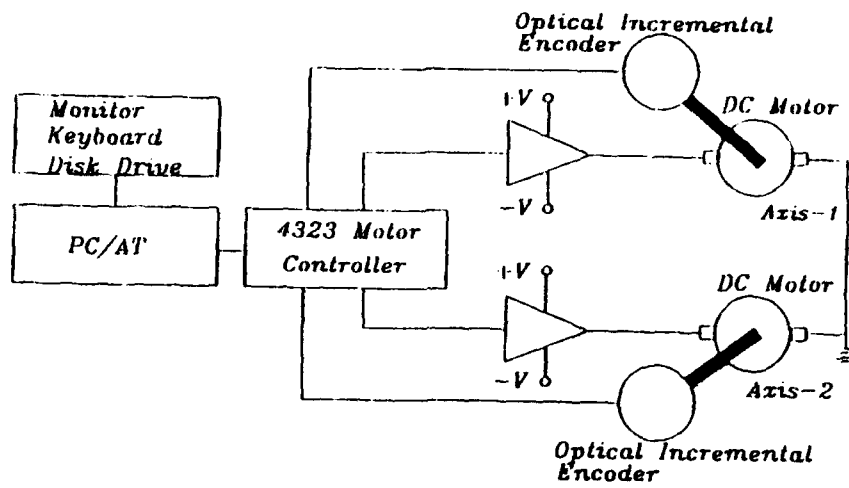


Figure 26. JT9D Automated Scanner Motor Controller

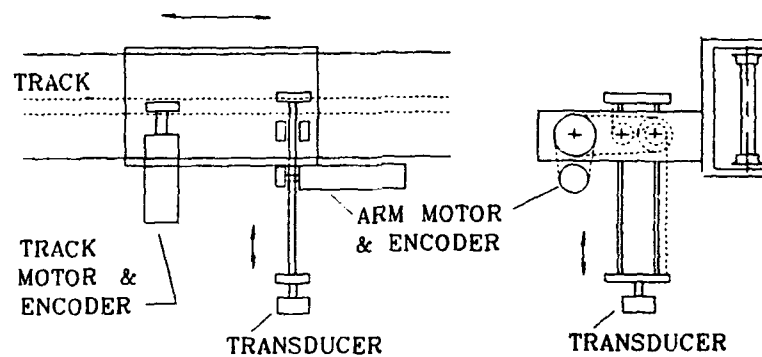


Figure 27. JT9D Motorized Scanner Sketch

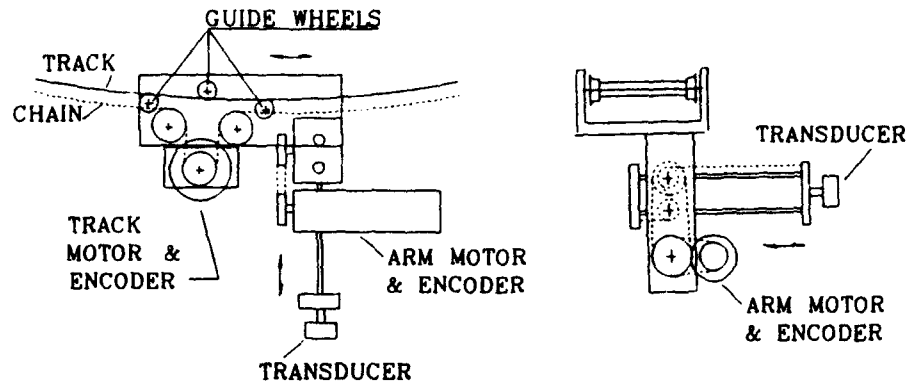


Figure 28. JT9D Motorized Scanner Track and Arm Mechanism

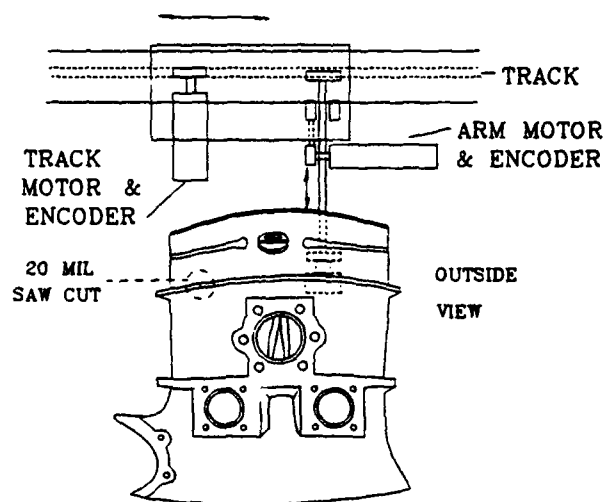


Figure 29. JT9D Motorized Scanner and Sample 2

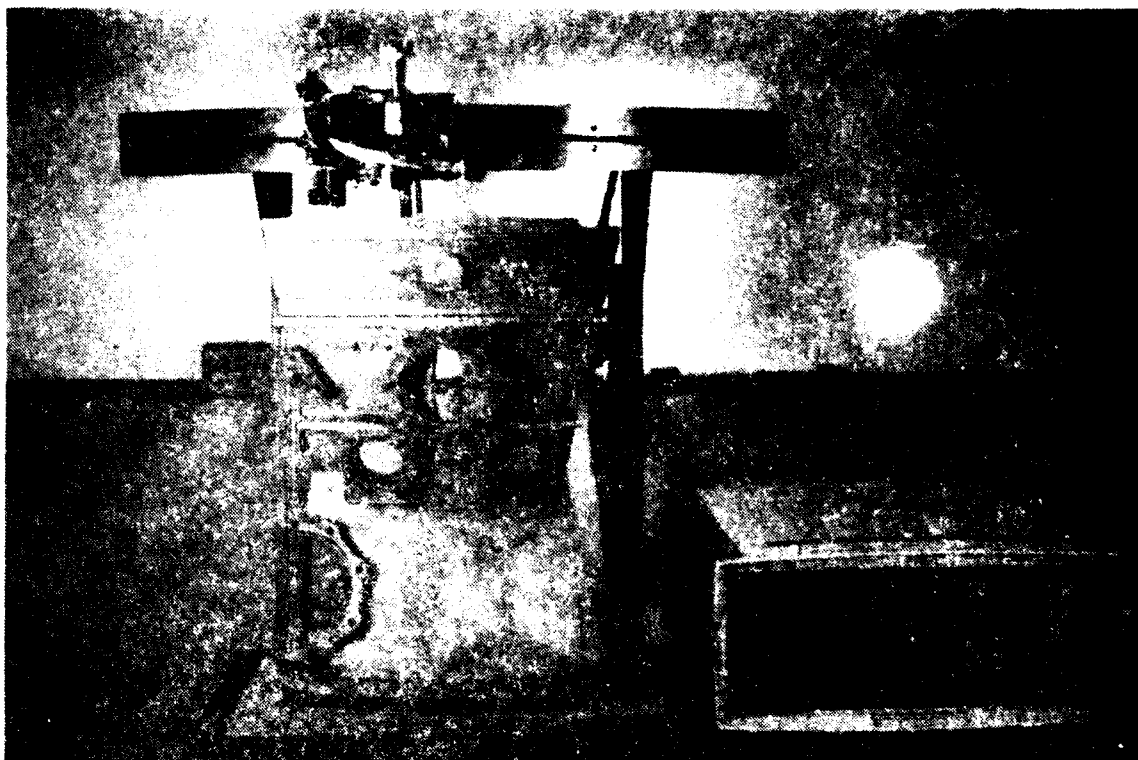
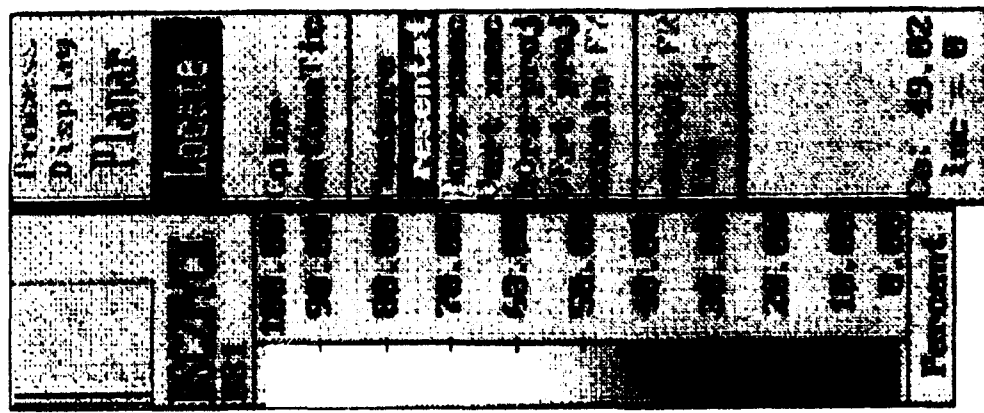
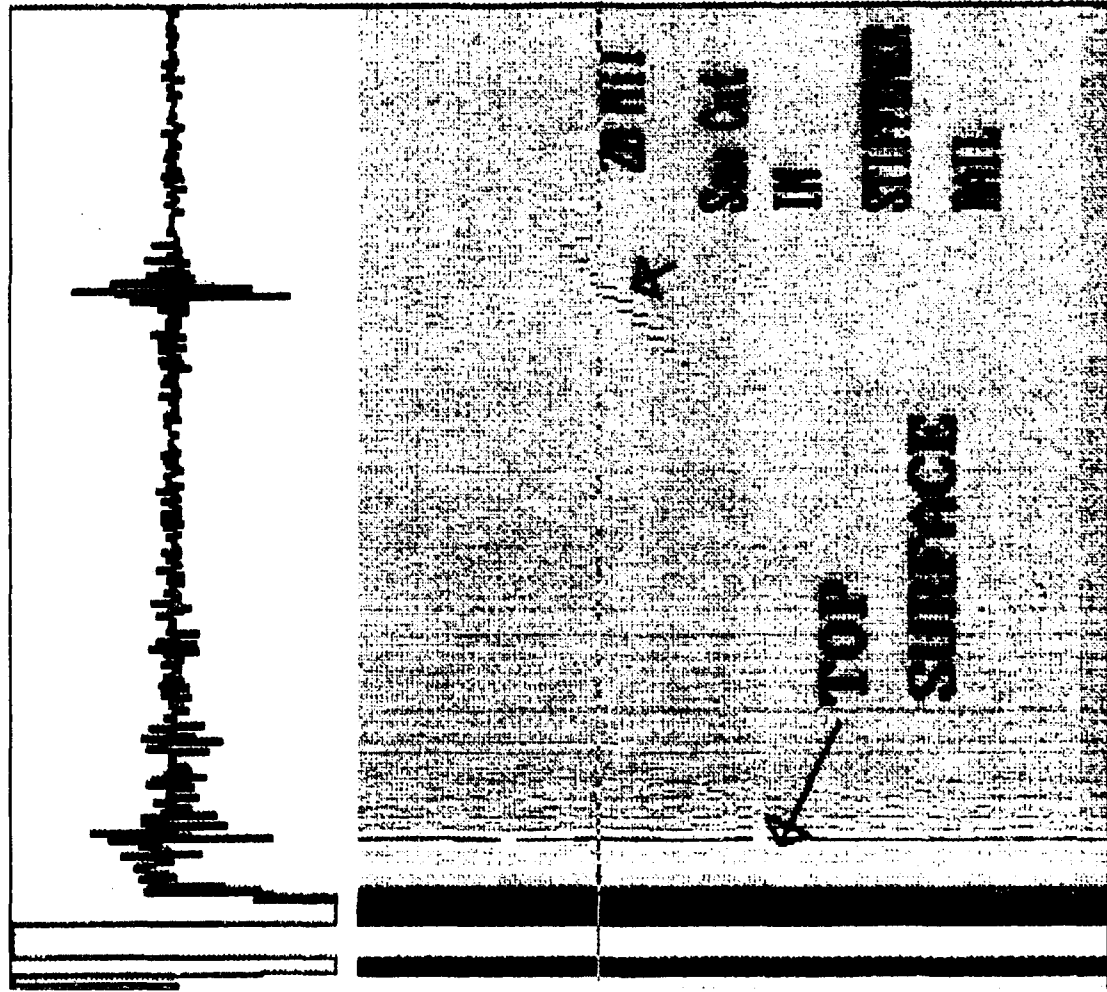


Figure 30. Picture of JT9D Motorized Scanner and Sample 2



A-SCAN



B-SCAN
JTYD
DIFFUSER
CASING

Sample 2
Shear 52

Pos	Min	Max	Total	Res.	Unit	AD
0.00	0.00	2.62	2.62	.000	in	XH
1.57	0.00	2.91	2.91	.039	in	YU

F1-Help <Esc>-Previous menu

Figure 31. Ultra Image Test BSC2PYCK, Shear Wave, Sample 2, A- and B-Scan

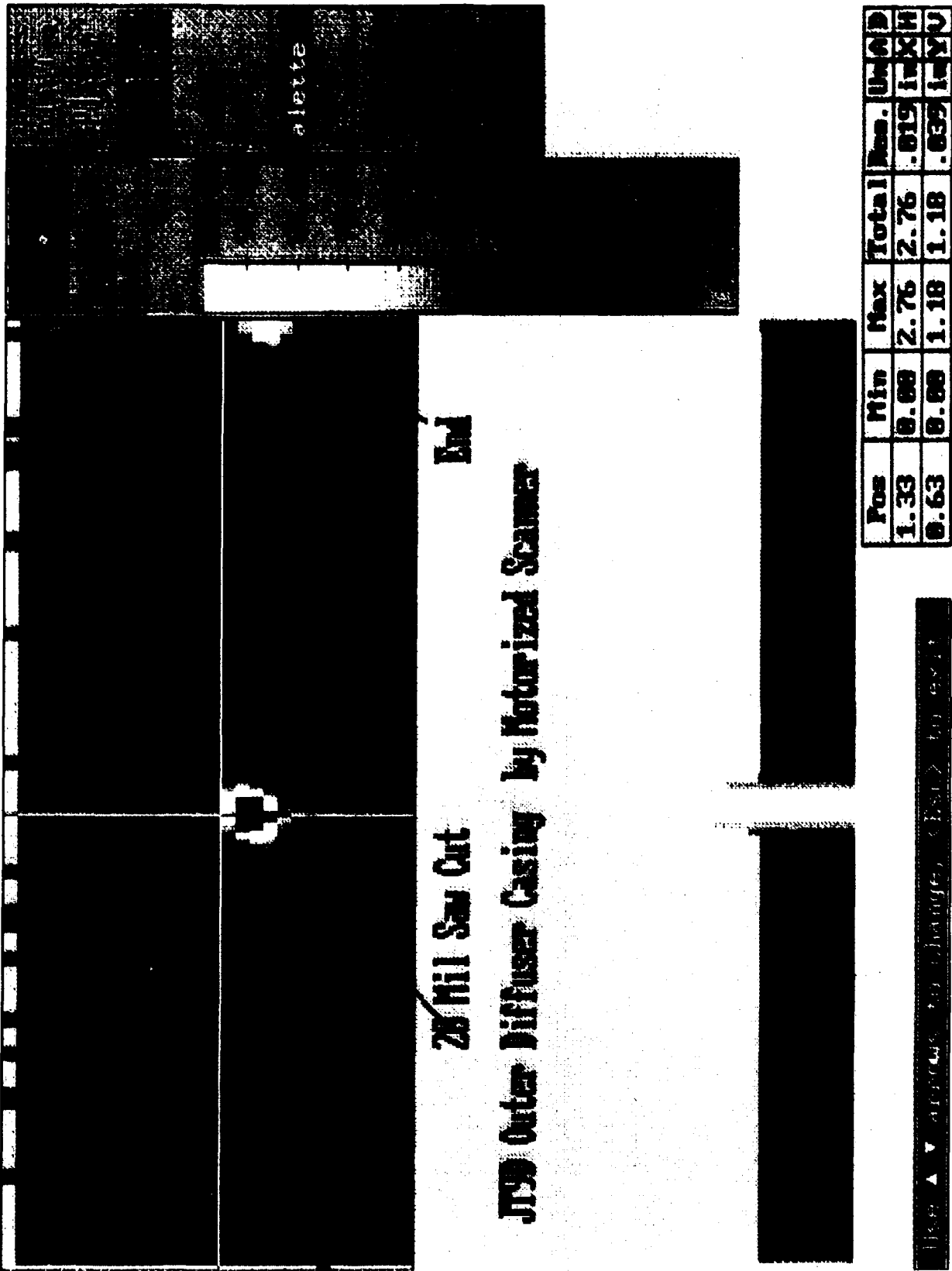


Figure 32. Ultra Image Test SANDIA-7, Shear Wave, Sample 2.
Motorized Scan From Inner Surface Of Case

CF6 ENGINE CASE FAILURE ANALYSIS

Review of the CF6 engine component failures documented in the FAA SDR data base from 1986 through the end of 1991 identified six case failures; one fan case failure, one CRF case failure, and four turbine mid-frame case failures.

The fan case failure included a crack at the 5 o'clock position (looking into the engine) between the frame support strut and the hub. This area is in the heat affected zone of the abutment weld area.

The CRF failure began in a weld area and progressed 360 degrees around the inner diffuser wall separating the aft flange. This type of failure can cause catastrophic engine failures as the case alignment shifts when the aft flange separates from the remainder of the case.

All four of the TMF failures were case cracks occurring in the case walls or at the C-sump area near the number 5 bearing attachment location. The cracks varied in length from 1.5 inches to four feet. The more severe cracks caused in-flight vibration and fire warning lights as high pressure turbine rotor shifts caused hot gases to activate the fire warning systems. The cracks occurred in case weld fabrication areas such as the number 5 bearing attachment fittings and engine mounts.

As with the JT9D engine case failure patterns, there were a series of failures originating in the fabrication weld, repair weld, or the weld affected zone. For early detection of weld deformities, some technique other than the surface detection approach using fluorescent penetrant is required. SAIC, using the UI-IV™ system, has demonstrated the ability to detect and track crack propagation in weld areas. Preliminary inspection procedures and data results using the UI-IV™ system for the TMF and the rear compressor case are described below.

CF6 ENGINE CASE NDI DEVELOPMENT

Four CF6 engine case samples were acquired from the GE Aircraft Engines Technology Quality Center in Cincinnati, Ohio. The samples consisted of three TMF samples and one CRF sample. A picture of each of the samples is shown in figure 33.

The first TMF sample, designated as CF6 Sample 1, is a section of the aft flange weld from a CF6-5D TMF. The material is forged Inconel 718 with a TIG weld fabrication. Two EDM notches were located on the inner diameter surface of the aft flange circumferential weld as shown in figure 34. Test CF6S2A was conducted on CF6 Sample 1 with the preliminary C-scan and amplitude plot imaging results shown in figure 35. The two EDM notches on either side of the weld are shown in figure 35, using an amplitude scan for sensitivity in defining the size of the EDM notches. A time of flight scan would exhibit the relative positions of the notches, but that view is not included in figure 35.

The second TMF sample, designated as CF6 Sample 2, is similar to CF6 Sample 1 except it includes a thermal coating on the inner diameter surface as shown in figure 36. On this sample, the EDM notch was over sprayed with a thermal coating. No information regarding size, shape or location was provided by GE. Test CF6S2A1 was performed using an angle beam transducer on the outer surface of the sample. The defects beneath the thermal coating were imaged using an UI-IV™ amplitude scan. The preliminary results of Test CF6S2A1 are shown in figure 37.

The third sample, designated as CF6 Sample 3, is also a portion of the TMF. CF6 Sample 3 contains two welded areas; a circumferential weld similar to those in CF6 Sample 1 and CF6 Sample 2, and a circular weld around the boss area. A sketch of CF6 Sample 3 is shown in figure 38. This sample contained seven notches as initiated and described by GE with the largest flaws being 0.250 inches long by 0.0015 inches deep and the smallest flaws being 0.0030 inches long by 0.0015 inches deep. Test CF6TMFS3 was conducted to inspect for flaws in the weld areas. Flaws in the circumferential weld as well as the boss weld area were not obvious in appearance, but were imaged using the UI-IV™ amplitude scan. The preliminary results of Test CF6TMFS3 are shown in figure 39, which exhibits three flaws. Detection of all of the flaws would be possible with transducer optimization.

The fourth sample was obtained from a CF6-80A CRF mid-flange and is designated CF6 Sample 4. The sample contained an EDM notch on the mid-flange scallop as shown in figure 40. The CRF mid-flange is manufactured from cast Inconel 718. Due to the coarse grain structure of the parent material, the background noise level is extremely high when using ultrasonics and the feedback made this inspection attempt a complex problem. A transducer selection was made to provide preliminary results. Test CRFA2 was performed and indications of the EDM notch in the flange scallop were exhibited. Figure 41

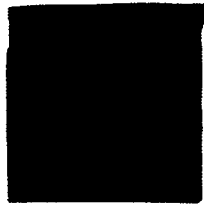
shows the results of Test CRFA2. Transducer optimization is required to improve image contrast in the cast grain structure.

The CF6 sample examinations provided preliminary results only. For comprehensive NDI procedures for the two CF6 engine cases, more development tests are needed. These development tests would include transducer parameter optimization, flaw signal characterization and tests of the UI-III™ and UI-IV™ systems for data acquisition and information displaying format. Continued collaboration with the engine manufacture and demonstrations of the acceptability of a procedure for either on-wing or maintenance shop application would be part of any validation cycle.

CF6 SAMPLES

TURBINE BID-FRAME (TMF)

TMF SAMPLE 1



TMF SAMPLE 2



TMF SAMPLE 3



COMPRESSOR REAR FRAME

(CRF)

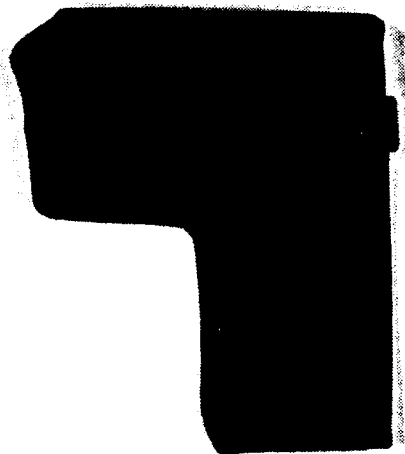


Figure 33. Picture of CF6 Samples, TMF, CRF

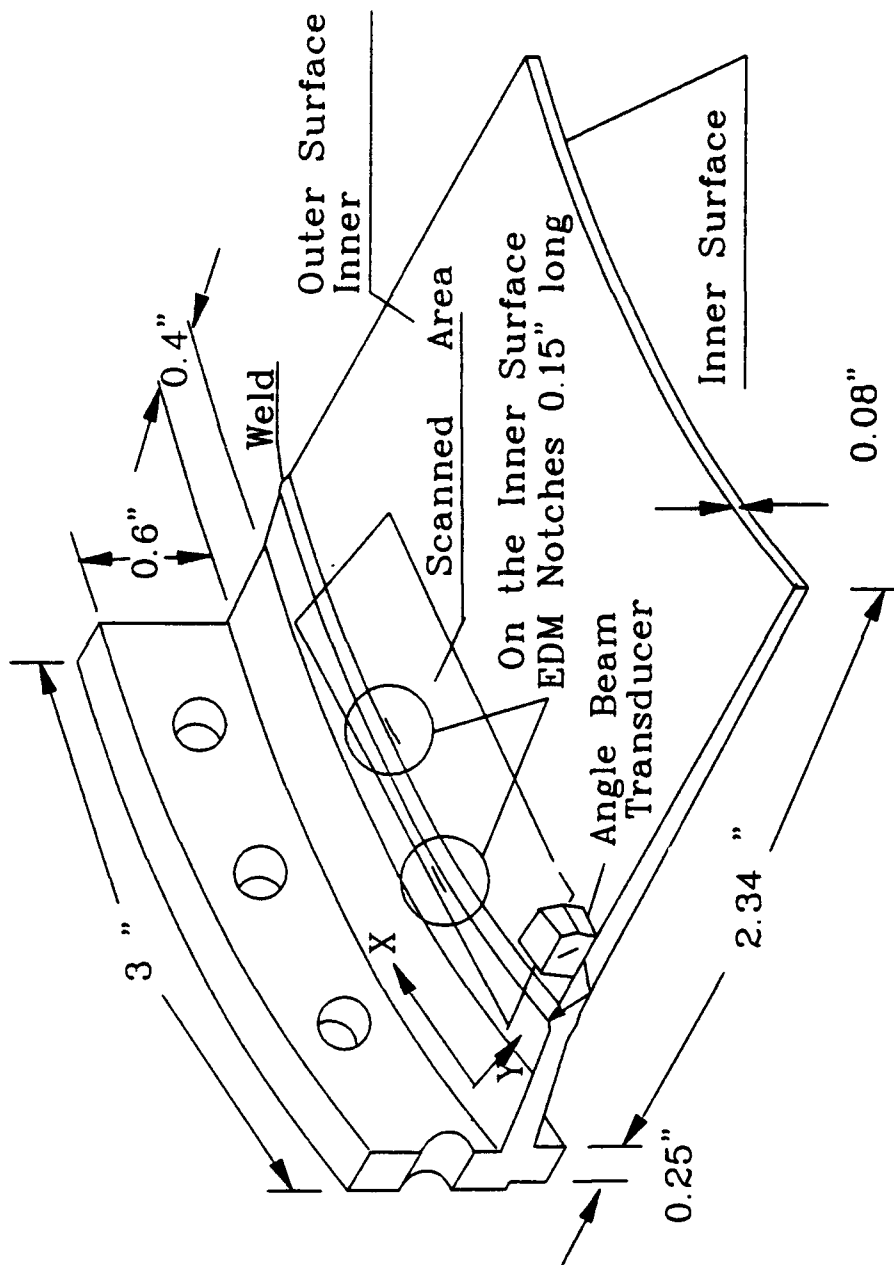


Figure 34. Sketch of CF8 Turbine Mid-Frame (TMF) Sample 1

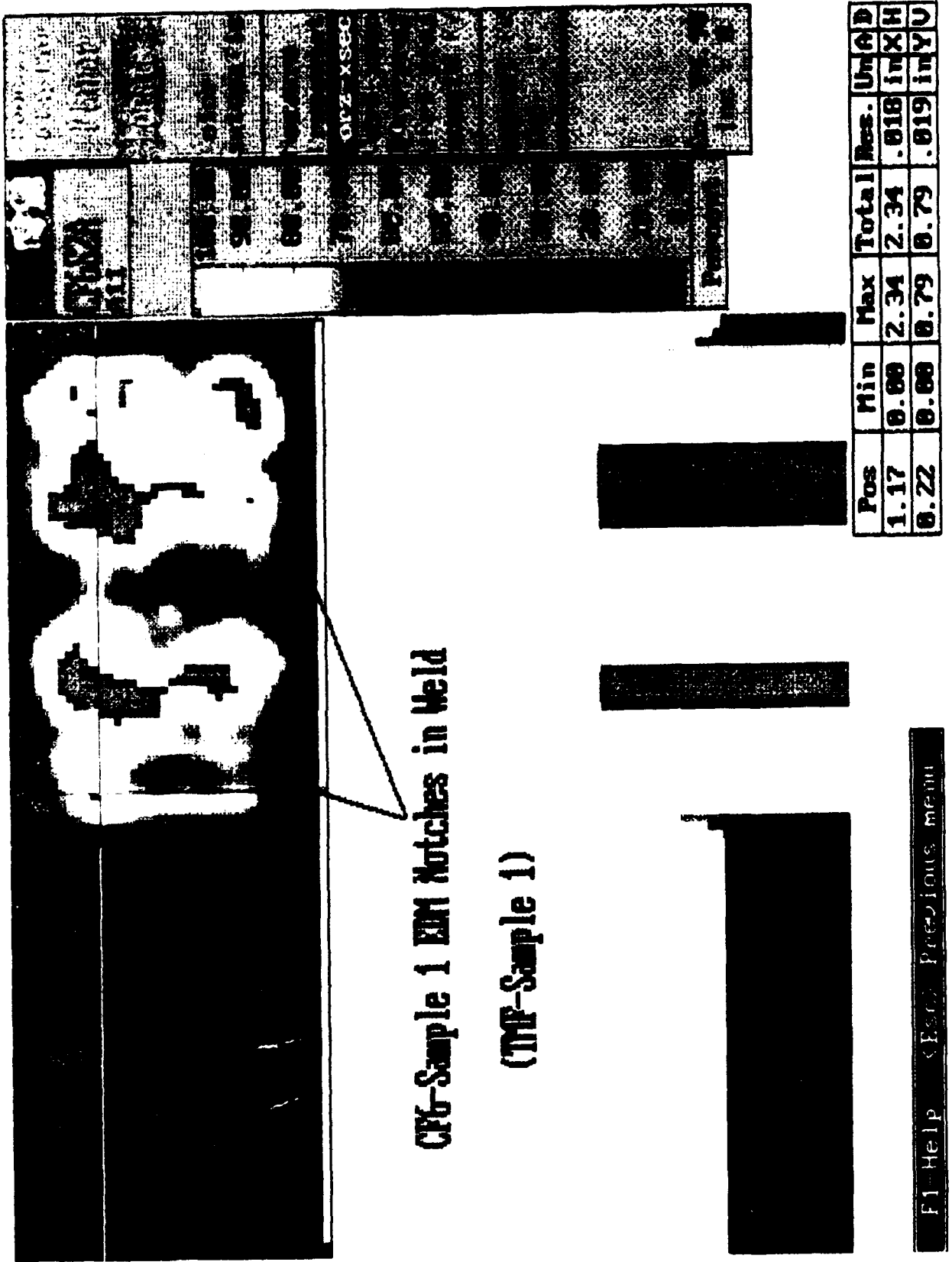


Figure 35. Ultra Image Test CP6S2A. Shear Wave, TMF, Sample 1

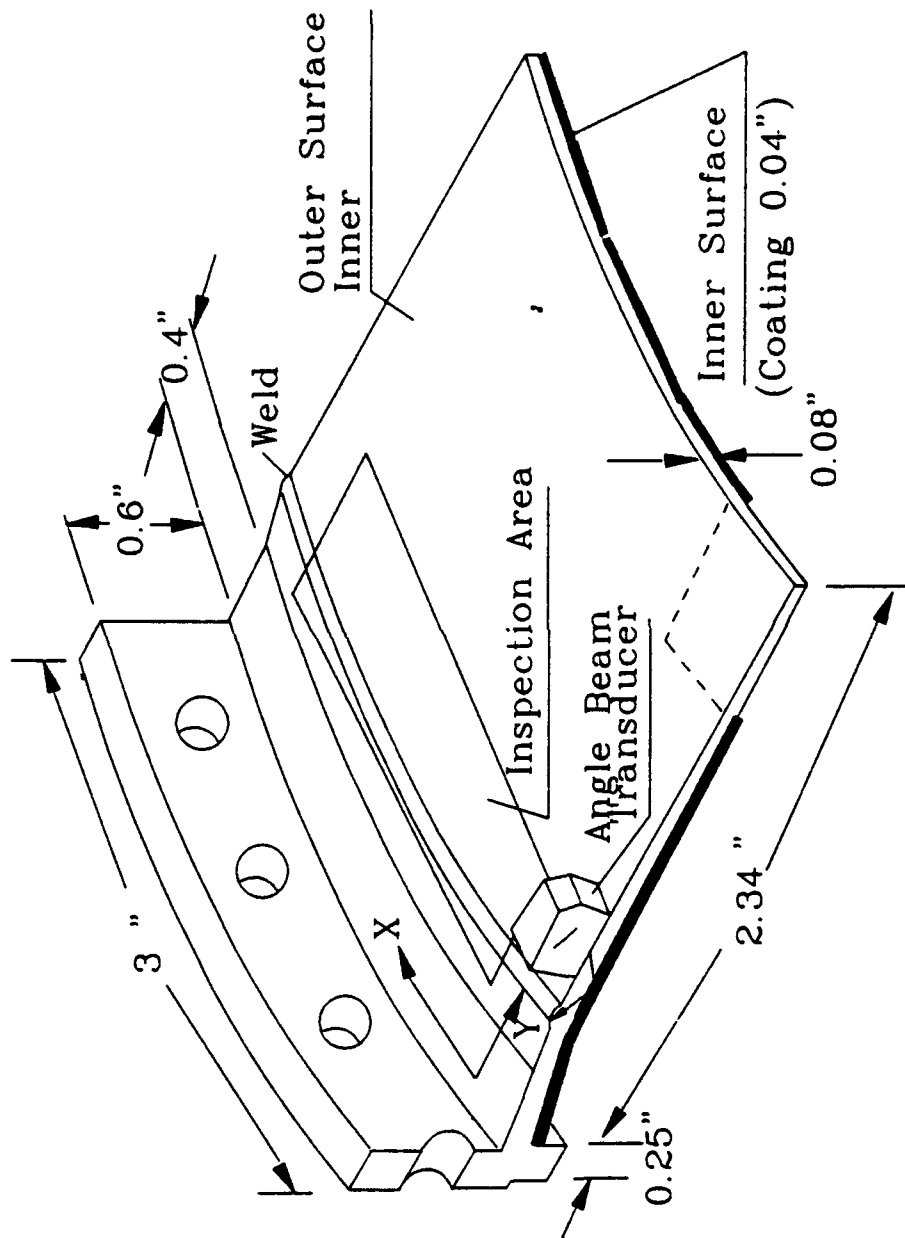


Figure 36. Sketch of CF8 Turbine Mid-Frame (TMF) Sample 2

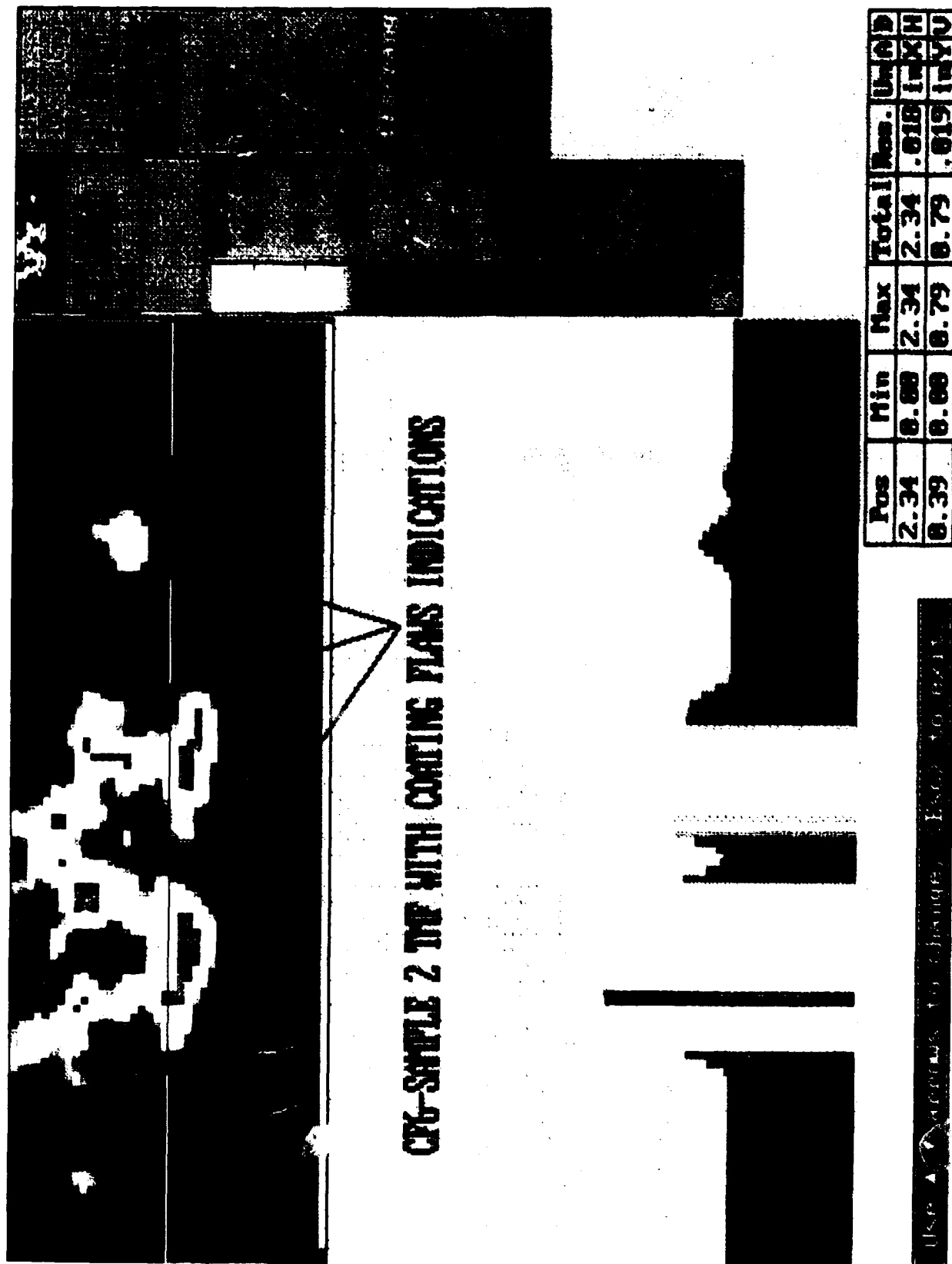


Figure 37. Ultra Image Test CF6S2A1. Shear Wave, TMF Sample 2

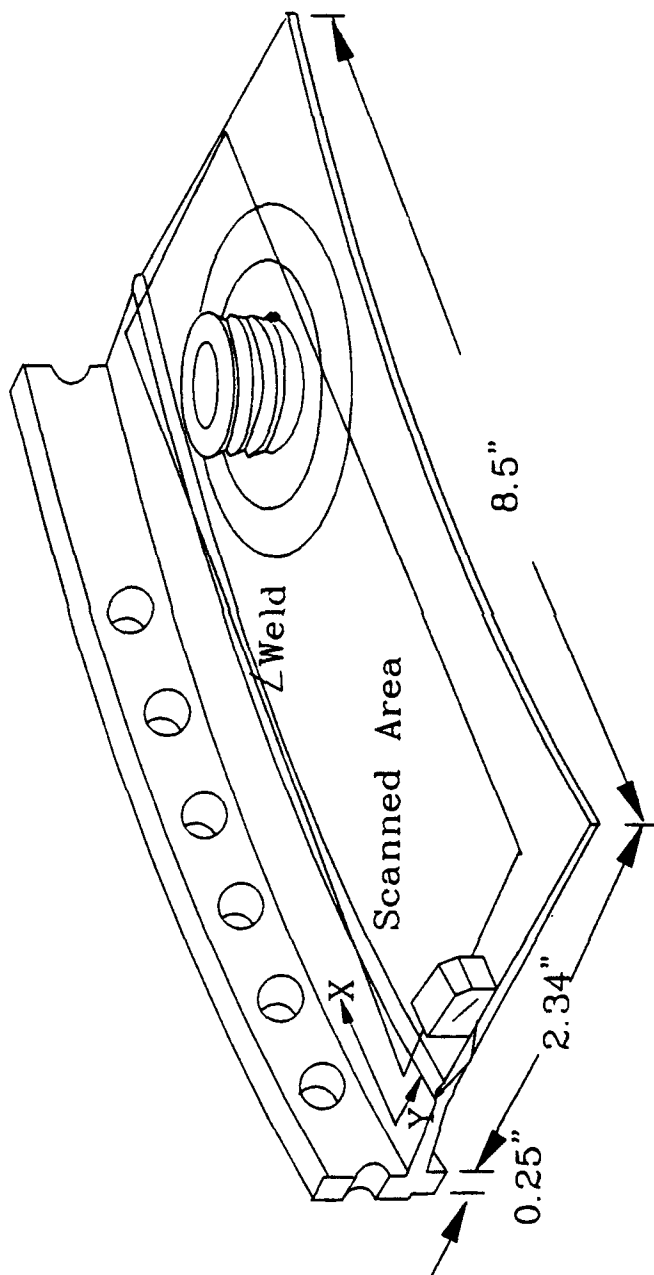


Figure 38. Sketch of CF8 Turbine Mid-Frame (TMF) Sample 3

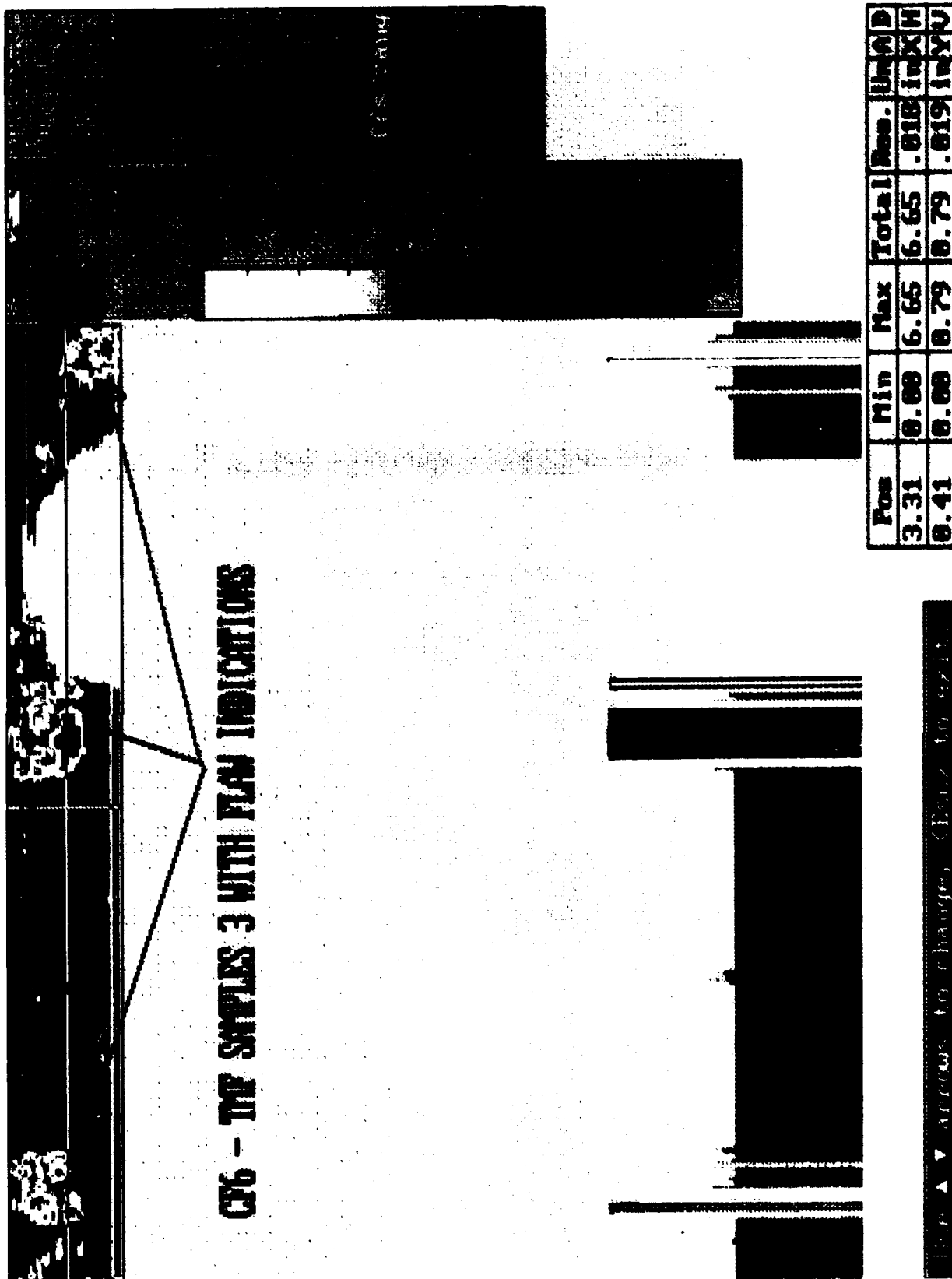


Figure 39. Ultra Image Test CF6TMFS3, Shear Wave, TMF Sample 3

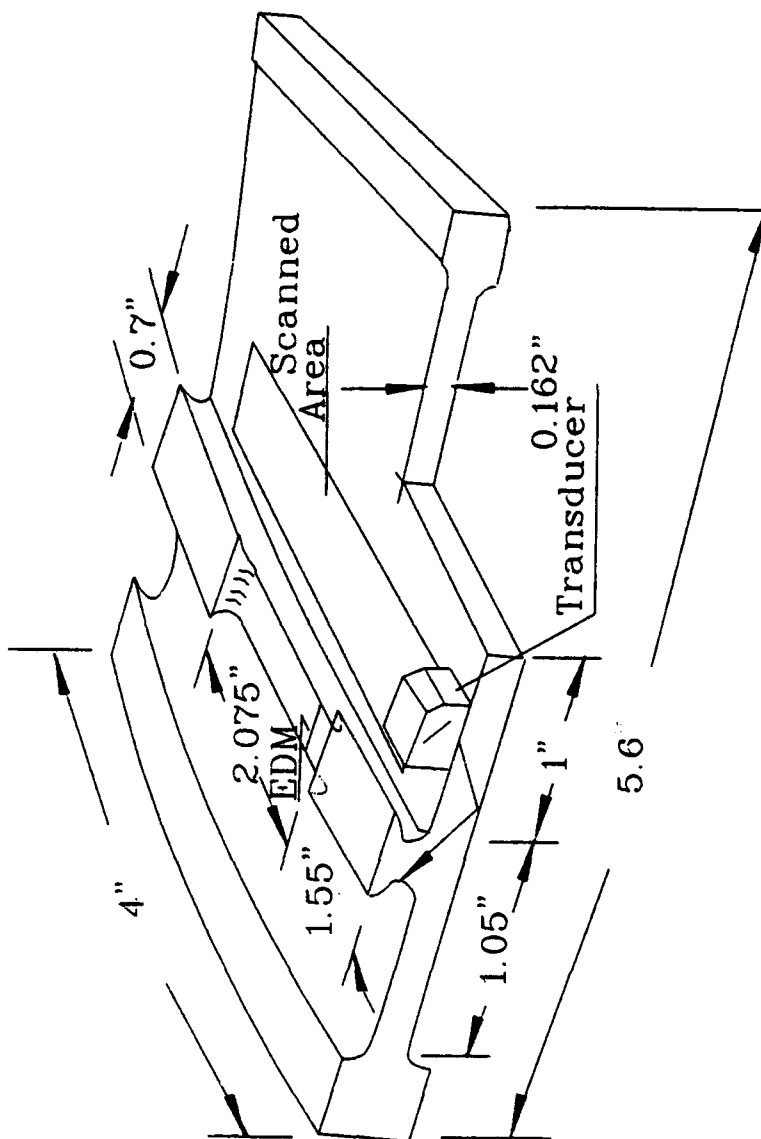


Figure 40. Sketch of CF8 Compressor Rear Frame (CRF) Sample

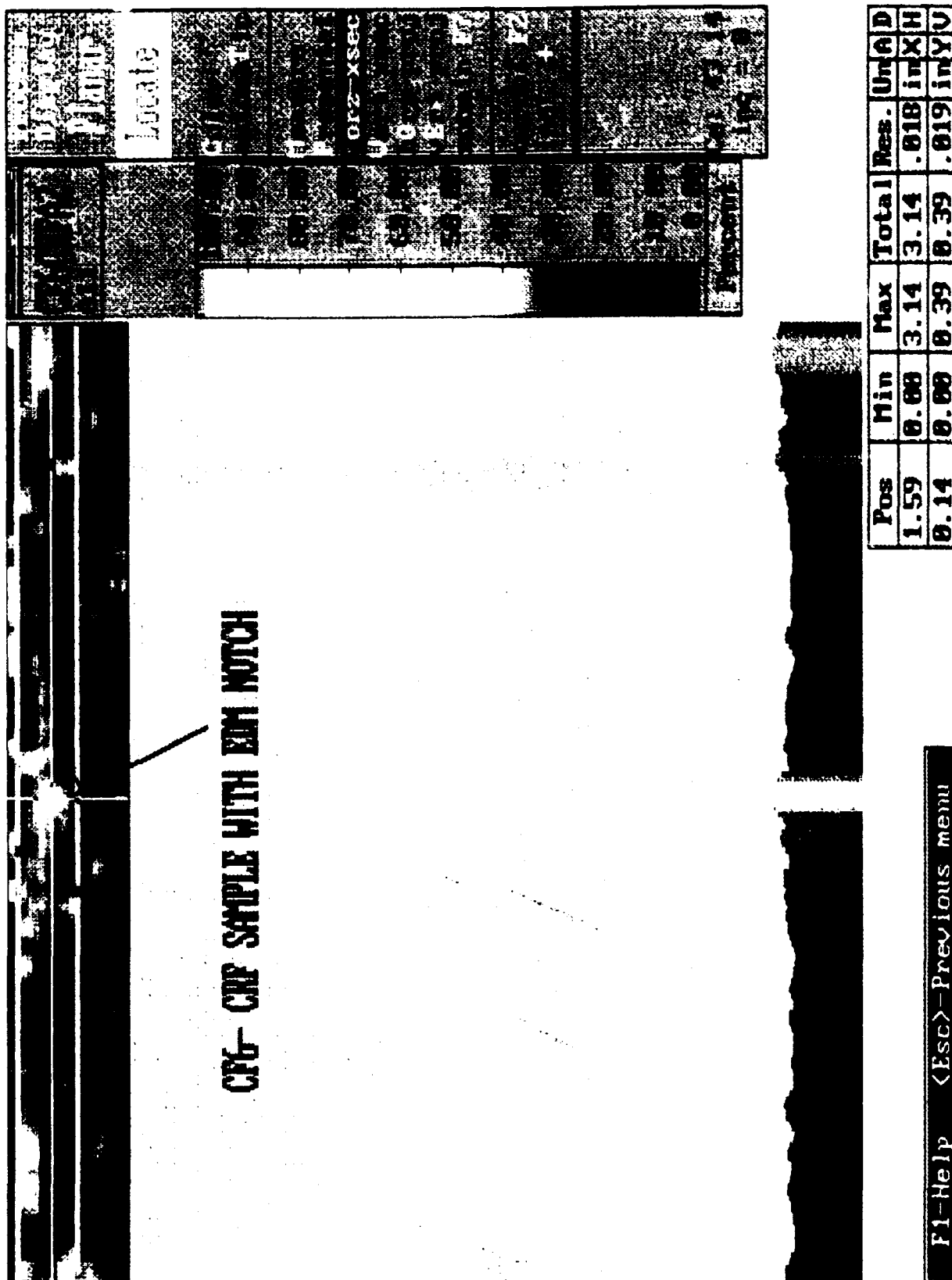


Figure 41. Ultra Image Test CFGCRFA2, Shear Wave, CRF Sample

CONCLUSIONS

The actuarial analysis methodology was effective in determining low reliability components for each engine reviewed. This was further confirmed through discussions with the engine manufacturers and selected carriers.

Although the design technology and material used for engine main bearings has improved, bearings were documented as a reliability problem.

Controls and accessories were responsible for the majority of in-flight shutdowns, flameouts and compressor stalls exhibited in the failure incident data covering the five year component trending period.

Diagnostic trouble shooting procedures for controls and accessories appear to be ineffective since multiple accessories are removed for precautionary measures to resolve in-flight flameouts and stalls.

Turbine airfoil component reliability has significantly improved with air cooling technology and DS material, but air cooled airfoils suffered severe damage during the compressor stalls and resulting rapidly increased EGT.

Some fuel/oil system failures were caused by maintenance errors such as oil caps unsecured, pinched seals, stripped mounting studs and left out gasket/shims.

The JT8D engine #6 bearing oil tube and 13th stage bleed air duct do not require improved NDI procedures. The enhanced configurations developed by the manufacturers of these items will resolve the documented low reliability performance.

The ultrasonic automated image enhancement method developed for the JT8D engine outer combustor case is applicable to similar weld inspection requirements on the JT9D engine diffuser case, CF6 engine compressor rear frame case and CF6 engine turbine mid-frame case.

Improved inspection procedures for characterization of repair welds is of interest to PWA and GE Aircraft Engines and their full cooperation in this study was obtained.

Defects 0.030 inch long and 0.020 inch deep in repair welds of service induced cracks of the JT9D engine diffuser case stiffener rail can be detected and imaged with a permanent recording using the UI-IVTTM system. This documentation recorded compliance of the inspection requirement and provided a baseline for structural integrity assessments.

APPENDIX A - ACTUARIAL IN-FLIGHT SHUTDOWN AND ENGINE REMOVAL DATA

JT9D MONTHLY PERFORMANCE			IN-FLIGHT SHUTDOWNS					
	Feb-88	Mar-88	Apr-88	May-88	Jun-88	Jul-88	Aug-88	Sep-88
B747								
INDUSTRY	0.17	0.20	0.16	0.16	0.19	0.15	0.14	0.13
CTA	0.72	0.44	0.08	0.11	0.28	0.08	0.00	0.00
ABC	0.06	0.25	0.18	0.17	0.22	0.15	0.15	0.10
AAA	0.00	0.27	0.00	0.25	0.00	0.52	1.69	0.00
QQQ	0.45	0.20	0.07	0.00	0.20	0.04	0.11	0.06
DEF	ND	ND	ND	ND	ND	ND	ND	ND
BKB	0.10	0.09	0.24	0.20	0.16	0.17	0.09	0.19
DAR	ND	0.00	0.00	0.51	0.00	0.34	0.17	0.00
LWZ	0.05	0.14	0.09	0.12	0.10	0.13	0.16	0.19
RAB	0.03	0.08	0.08	0.08	0.10	0.08	0.09	0.03
DDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ILT	0.00	ND	0.00	0.00	0.00	0.00	ND	0.00
JKL	ND	ND	ND	ND	ND	0.00	0.00	0.00
NNN	ND	ND	ND	ND	ND	ND	ND	ND
B767								
INDUSTRY	0.00	0.24	0.00	0.17	0.17	0.10	0.00	0.00
LWZ	0.00	0.13	0.00	0.00	0.00	0.12	0.00	0.00
RAB	0.00	0.16	0.00	0.17	0.17	0.00	0.00	0.00
DC15								
INDUSTRY	0.31	0.27	0.16	0.25	0.30	0.42	0.20	0.39
BKB	0.19	0.17	0.08	0.15	0.20	0.30	0.12	0.27
NZT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Oct-88	Nov-88	Dec-88	Jan-89	Feb-89	Mar-89	Apr-89	May-89
B747								
INDUSTRY	0.15	0.10	0.13	0.13	0.12	0.15	0.18	0.14
CTA	0.10	0.00	0.00	0.19	0.00	0.12	0.23	0.00
ABC	0.18	0.09	0.13	0.00	0.08	0.08	0.16	0.20
AAA	1.62	0.00	ND	0.00	0.00	0.00	0.00	ND
QQQ	0.17	0.13	0.21	0.13	0.14	0.23	0.04	0.11
DEF	ND	ND	ND	ND	ND	ND	ND	ND
BKB	0.16	0.11	0.15	0.13	0.08	0.04	0.10	0.10
DAR	0.24	0.41	0.20	0.40	0.00	0.26	0.32	0.00
LWZ	0.14	ND	0.05	0.19	0.16	0.04	0.04	0.16
RAB	0.00	0.00	0.07	0.13	0.09	0.28	0.30	0.12
DDA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ILT	ND	ND	0.00	0.00	ND	ND	0.59	0.00
JKL	0.30	0.00	0.00	0.31	0.62	0.00	0.31	0.00
NNN	ND	ND	ND	ND	ND	ND	ND	ND
B767								
INDUSTRY	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.17
LWZ	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.13
RAB	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.08
DC10								
INDUSTRY	0.22	0.00	0.33	0.00	0.14	0.67	0.00	0.22
BKB	0.27	0.00	0.21	0.00	0.08	0.50	0.00	0.13
NZT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Jun-89	Jul-89	Aug-89	Sep-89	Oct-89	Nov-89	Dec-89	Jan-90
B747								
INDUSTRY	0.09	0.15	0.17	0.12	0.09	0.13	0.21	0.14
CTA	0.17	0.00	0.08	0.08	0.08	0.09	0.26	0.09
ABC	0.04	0.17	0.06	0.09	0.07	0.17	0.26	0.26
AAA	ND	ND	ND	ND	ND	ND	ND	ND
QQQ	0.03	ND	ND	ND	ND	ND	ND	ND
DEF	ND	ND	0.04	0.11	0.00	0.11	0.08	0.05
BKB	0.12	0.17	0.25	0.12	0.13	0.02	0.25	0.08
DAR	0.00	0.00	0.36	0.00	0.23	0.24	0.20	0.00
LWZ	0.07	0.10	0.10	0.11	0.09	0.09	0.17	0.04
RAB	0.04	0.07	0.11	0.10	0.06	0.19	0.05	0.10
DDA	0.00	0.71	0.00	0.76	0.00	0.36	0.00	0.00
ILT	ND	0.40	0.32	ND	ND	0.00	ND	ND
JKL	0.00	0.00	1.02	ND	0.00	0.00	0.25	0.59
NNN	ND	ND	ND	ND	0.00	0.00	0.00	0.00
B767								
INDUSTRY	0.17	0.00	0.00	0.25	0.00	0.00	0.00	0.00
LWZ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RAB	0.16	0.00	0.00	0.27	0.00	0.00	0.00	0.00
DC10								
INDUSTRY	0.25	0.31	0.31	0.40	0.33	0.21	0.28	0.20
BKB	0.17	0.22	0.22	0.29	0.23	0.13	0.19	0.12
NZT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90
B747								
INDUSTRY	0.15	0.10	0.19	0.12	0.20	0.16	0.16	0.11
CTA	0.00	0.00	0.20	0.21	0.09	0.00	ND	ND
ABC	0.18	0.16	0.18	ND	0.41	0.35	0.14	0.04
AAA	ND	ND	ND	ND	ND	ND	ND	ND
QQQ	ND	ND	ND	ND	ND	ND	ND	ND
DEF	0.06	0.04	0.43	0.17	0.26	0.05	0.22	0.00
BKB	0.19	0.13	0.13	0.10	0.14	0.16	0.16	0.21
DAR	0.00	0.00	ND	0.00	0.27	0.00	0.34	0.00
LWZ	0.15	0.04	0.00	0.00	0.07	0.04	0.04	0.08
RAB	0.05	0.00	0.12	0.10	0.02	0.04	0.13	0.04
DDA	0.00	0.35	0.37	0.00	0.00	0.37	0.39	0.00
ILT	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.19
JKL	0.31	0.00	0.52	0.25	0.27	0.00	0.25	0.00
NNN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43
B767								
INDUSTRY	0.00	0.00	0.10	0.10	0.00	0.10	0.00	0.00
LWZ	0.00	0.00	0.00	0.14	0.00	0.11	0.00	0.00
RAB	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00
DC10								
INDUSTRY	0.66	0.19	0.20	0.12	0.24	0.17	0.46	0.34
BKB	0.51	0.12	0.12	0.06	0.16	0.10	0.35	0.24
NZT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

JT9D MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
	Oct-90	Nov-90	Dec-90	Jan-91				
B747								
INDUSTRY	0.20	0.18	0.17	0.15				
CTA	0.31	0.00	0.55	0.08				
ABC	0.25	0.17	0.16	0.20				
AAA	ND	ND	ND	ND				
QQQ	ND	ND	ND	ND				
DEF	0.13	0.09	0.00	0.06				
BKB	ND	ND	ND	ND				
DAR	1.09	0.55	0.39	0.75				
LWZ	0.13	0.17	0.22	0.12				
RAB	0.02	ND	0.02	0.04				
DDA	0.00	0.00	ND	0.00				
ILT	0.20	0.12	0.18	0.18				
JKL	0.00	0.00	0.00	0.00				
NNN	0.00	0.20	0.00	0.00				
B767								
INDUSTRY	0.10	0.26	0.00	0.00				
LWZ	0.13	0.13	0.00	0.00				
RAB	0.00	ND	0.00	0.00				
DC10								
INDUSTRY	ND	ND	ND	ND				
BKB	ND	ND	ND	ND				
NZT	ND	ND	ND	ND				

JT9D MONTHLY PERFORMANCE			ENGINE REMOVALS					
	Feb-88	Mar-88	Apr-88	May-88	Jun-88	Jul-88	Aug-88	Sep-88
B747								
INDUSTRY	0.16	0.31	0.20	0.32	0.27	0.25	0.25	0.20
CTA	0.14	0.33	0.24	0.15	0.28	0.34	0.26	0.00
ABC	0.06	0.23	0.22	0.27	0.30	0.34	0.30	0.22
AAA	0.00	0.55	0.30	0.00	0.00	0.00	0.00	0.00
QQQ	0.19	0.28	0.08	0.15	0.17	0.22	0.14	0.17
DEF	ND	ND	ND	ND	ND	ND	ND	ND
BKB	0.22	0.28	0.17	0.10	0.24	0.25	0.27	0.21
DAR	ND	0.27	0.62	0.00	0.00	0.00	0.17	0.24
LWZ	0.10	0.14	0.14	0.16	0.14	0.13	0.03	0.00
RAB	0.11	0.25	0.15	0.66	0.27	0.14	0.28	0.16
DDA	0.00	0.00	0.85	0.72	0.00	0.00	0.00	0.00
ILT	0.00	ND	0.00	0.00	2.25	0.00	ND	0.41
JKL	ND	ND	ND	ND	ND	0.00	0.00	0.33
NNN	ND	ND	ND	ND	ND	ND	ND	ND
B767								
INDUSTRY	0.25	0.30	0.17	0.44	0.17	0.35	0.29	0.17
LWZ	0.14	0.00	0.00	0.28	0.00	0.62	0.00	0.00
RAB	0.17	0.31	0.16	0.33	0.17	0.00	0.32	0.16
DC10								
INDUSTRY	0.00	0.48	0.27	0.25	0.61	0.49	0.49	0.55
BKB	0.00	0.33	0.17	0.15	0.44	0.37	0.36	0.41
NZT	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00
	Oct-88	Nov-88	Dec-88	Jan-89	Feb-89	Mar-89	Apr-89	May-89
B747								
INDUSTRY	0.23	0.24	0.26	0.18	0.21	0.19	0.26	0.22
CTA	0.48	0.00	0.20	0.18	0.13	0.23	0.20	0.41
ABC	0.16	0.19	0.18	0.00	0.08	0.14	0.18	0.22
AAA	0.00	0.00	ND	0.00	1.32	0.00	0.00	ND
QQQ	0.21	0.14	0.32	0.04	0.25	0.10	0.38	0.20
DEF	ND	ND	ND	ND	ND	ND	ND	ND
BKB	0.20	0.18	0.20	0.23	0.25	0.13	0.14	0.12
DAR	0.24	0.41	0.20	0.00	0.00	0.00	0.00	0.57
LWZ	0.05	ND	0.14	0.29	0.21	0.22	0.26	0.04
RAB	0.28	0.24	0.29	0.24	0.11	0.28	0.28	0.27
DDA	0.00	0.37	0.00	0.00	1.85	0.00	0.00	0.00
ILT	ND	ND	0.00	0.00	ND	ND	1.02	0.00
JKL	0.30	0.29	0.77	0.31	0.31	0.00	0.31	0.27
NNN	ND	ND	ND	ND	ND	ND	ND	ND
B767								
INDUSTRY	0.23	0.26	0.17	0.10	0.32	0.41	0.38	0.36
LWZ	0.13	ND	0.13	0.14	0.00	0.28	0.15	0.00
RAB	0.15	0.15	0.15	0.08	0.33	0.30	0.32	0.40
DC10								
INDUSTRY	0.55	0.35	0.51	0.14	0.63	0.75	0.24	0.39
BKB	0.41	0.23	0.36	0.07	0.47	0.50	0.15	0.26
NZT	0.00	0.00	0.00	0.00	0.00	2.03	0.00	0.00

JT9D MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
	Jun-89	Jul-89	Aug-89	Sep-89	Oct-89	Nov-89	Dec-89	Jan-90
B747								
INDUSTRY	0.19	0.25	0.24	0.23	0.22	0.26	0.23	0.23
CTA	0.17	0.33	0.24	0.17	0.23	0.27	0.56	0.34
ABC	0.08	0.23	0.19	0.16	0.12	0.27	0.33	0.16
AAA	ND	ND	ND	ND	ND	ND	ND	ND
QQQ	0.18	ND	ND	ND	ND	ND	ND	ND
DEF	ND	ND	0.16	0.27	0.30	0.26	0.22	0.41
BKB	0.21	0.23	0.27	0.31	0.23	0.22	0.17	0.14
DAR	0.00	0.00	0.54	0.00	0.23	0.00	0.20	0.43
LWZ	0.17	0.26	0.20	0.19	0.17	0.28	0.00	0.09
RAB	0.17	0.14	0.20	0.20	0.15	0.13	0.13	0.15
DDA	0.00	0.00	0.00	0.00	0.35	0.36	0.00	0.49
ILT	ND	3.01	0.00	ND	ND	0.63	ND	ND
JKL	0.28	0.00	0.25	ND	0.21	0.53	0.25	0.59
NNN	ND	ND	ND	ND	0.00	0.00	0.00	0.38
B767								
INDUSTRY	0.36	0.36	0.00	0.25	0.33	0.19	0.17	0.31
LWZ	0.26	0.13	0.00	0.13	0.17	0.15	0.00	0.13
RAB	0.24	0.33	0.00	0.18	0.25	0.09	0.17	0.26
DC10								
INDUSTRY	0.45	0.38	0.38	0.27	0.33	0.12	0.28	0.56
BKB	0.33	0.27	0.27	0.17	0.23	0.06	0.19	0.43
NZT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90
B747								
INDUSTRY	0.23	0.21	0.25	0.21	0.31	0.26	0.29	0.24
CTA	0.13	0.16	0.20	0.21	0.44	0.07	ND	ND
ABC	0.34	0.14	0.28	ND	0.26	0.31	0.26	0.19
AAA	ND	ND	ND	ND	ND	ND	ND	ND
QQQ	ND	ND	ND	ND	ND	ND	ND	ND
DEF	0.29	0.12	0.37	0.05	0.46	0.10	0.32	0.24
BKB	0.14	0.26	0.28	0.22	0.19	0.26	0.28	0.29
DAR	0.00	0.00	ND	0.00	0.27	0.19	0.00	0.20
LWZ	0.21	0.17	0.22	0.08	0.33	0.26	0.18	0.20
RAB	0.20	0.16	0.05	0.25	0.26	0.18	0.30	0.17
DDA	0.00	0.35	0.37	0.00	0.37	0.37	0.39	0.38
ILT	0.00	0.00	0.00	0.16	0.26	ND	0.00	0.19
JKL	0.31	0.28	0.26	0.25	0.27	0.83	0.49	0.00
NNN	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.22
B767								
INDUSTRY	0.48	0.54	0.31	0.58	0.17	0.29	0.22	0.29
LWZ	0.28	0.37	0.00	0.28	0.12	0.00	0.11	0.00
RAB	0.37	0.42	0.35	0.52	0.08	0.34	0.16	0.33
DC10								
INDUSTRY	0.52	0.41	0.42	0.42	0.42	0.29	0.29	0.62
BKB	0.39	0.30	0.30	0.29	0.31	0.20	0.20	0.47
NZT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

JT9D MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)							
	Oct-90	Nov-90	Dec-90	Jan-91			
B747							
INDUSTRY	0.20	0.18	0.17	0.15			
CTA	0.31	0.00	0.55	0.08			
ABC	0.25	0.17	0.16	0.20			
AAA	ND	ND	ND	ND			
QQQ	ND	ND	ND	ND			
DEF	0.18	0.14	0.18	0.30			
BKB	ND	ND	ND	ND			
DAR	0.00	0.00	0.00	0.00			
LWZ	0.27	0.23	0.09	0.12			
RAB	0.27	ND	0.16	0.21			
DDA	0.00	0.00	ND	0.00			
ILT	0.12	0.12	0.53	0.43			
JKL	0.52	1.02	0.22	0.20			
NNN	0.00	0.41	0.00	0.26			
B767							
INDUSTRY	0.42	0.26	0.30	0.17			
LWZ	0.13	0.13	0.13	0.00			
RAB	0.41	ND	0.24	0.16			
DC10							
INDUSTRY	ND	ND	ND	ND			
BKB	ND	ND	ND	ND			
NZT	ND	ND	ND	ND			

CF6 MONTHLY PERFORMANCE			IN-FLIGHT SHUTDOWNS					
	Feb-88	Mar-88	Apr-88	May-88	Jun-88	Jul-88	Aug-88	Sep-88
A300								
INDUSTRY	0.14	0.00	0.00	0.08	0.08	0.00	0.26	0.08
ABC	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00
CTA	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.20
XYZ	0.08	0.00	0.00	0.00	0.08	0.00	0.09	0.00
DDA	ND	ND	0.00	1.68	0.00	0.00	0.00	0.00
B767								
INDUSTRY	0.00	0.00	0.06	0.00	0.00	0.00	0.04	0.04
DDA	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00
SSS	0.00	0.00	0.00	0.00	0.00	0.00	ND	0.00
FPC	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06
GGA	ND	ND	ND	ND	ND	ND	ND	ND
DC10								
INDUSTRY	0.10	0.07	0.07	0.08	0.05	0.08	0.09	0.06
DDA	0.02	0.10	0.07	0.08	0.04	0.09	0.07	0.04
CTA	0.21	0.13	0.07	0.14	0.00	0.00	0.05	0.00
FPC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DEF	0.46	0.00	0.00	0.18	0.00	0.20	0.16	0.00
PPP	ND	ND	ND	ND	ND	ND	ND	ND
RAB	0.07	0.00	0.03	0.02	0.00	0.04	0.09	0.07
TMR	0.00	0.00	0.38	ND	0.51	0.00	0.00	0.00
XYZ	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00
	Oct-88	Nov-88	Dec-88	Jan-89	Feb-89	Mar-89	Apr-89	May-89
A300								
INDUSTRY	0.08	0.19	0.08	0.12	0.08	0.00	0.10	0.00
ABC	0.00	0.20	0.19	0.00	0.00	0.00	0.21	0.00
CTA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XYZ	0.00	0.12	0.00	0.10	0.11	0.00	0.00	0.00
DDA	0.18	0.16	0.00	0.15	0.00	0.00	0.00	0.00
B767								
INDUSTRY	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.00
DDA	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
SSS	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00
FPC	ND	0.00	0.00	0.00	0.00	ND	0.00	0.00
GGA	ND	ND	ND	ND	ND	ND	ND	ND
DC10								
INDUSTRY	0.04	0.05	0.05	0.09	0.05	0.07	0.09	0.07
DDA	0.02	0.07	0.00	0.06	0.04	0.04	0.06	0.06
CTA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
FPC	ND	0.00	0.00	ND	ND	ND	ND	ND
DEF	0.00	0.00	0.08	0.09	0.18	0.00	0.00	0.09
PPP	ND	ND	ND	ND	ND	ND	ND	0.00
RAB	0.00	0.00	0.00	0.08	0.03	0.10	0.11	0.04
TMR	0.00	0.00	0.00	0.29	0.00	0.00	0.17	0.00
XYZ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CF6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
	Jun-89	Jul-89	Aug-89	Sep-89	Oct-89	Nov-89	Dec-89	Jan-90
A300								
INDUSTRY	0.08	0.12	0.06	0.00	0.00	0.12	0.00	0.00
ABC	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00
CTA	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XYZ	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00
DDA	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00
B767								
INDUSTRY	0.00	0.00	0.04	0.00	0.07	0.00	0.04	0.00
DDA	0.00	0.00	0.05	0.00	0.06	0.00	0.00	0.00
SSS	0.00	ND	ND	ND	ND	ND	ND	ND
FPC	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00
GGA	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
DC10								
INDUSTRY	0.04	0.09	0.03	0.08	0.04	0.08	0.06	0.08
DDA	0.04	0.08	0.02	0.04	0.03	0.06	0.04	0.12
CTA	0.00	0.14	0.00	0.19	0.00	0.00	0.00	0.09
FPC	ND	ND	ND	ND	ND	ND	ND	ND
DEF	0.00	0.00	0.07	0.00	0.05	0.05	0.00	0.00
PPP	0.00	0.00	1.42	0.00	0.00	0.00	ND	ND
RAB	0.04	0.07	0.00	0.09	0.03	0.08	0.05	0.03
TMR	0.00	0.00	0.00	0.16	0.00	0.00	0.14	0.00
XYZ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90
A300								
INDUSTRY	0.08	0.06	0.00	0.13	0.00	0.00	0.00	0.00
ABC	0.00	0.18	0.00	ND	0.00	0.00	0.00	0.00
CTA	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND
XYZ	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DDA	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00
B767								
INDUSTRY	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.00
DDA	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00
SSS	ND	ND	ND	ND	ND	ND	ND	ND
FPC	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00
GGA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DC10								
INDUSTRY	0.03	0.06	0.06	0.02	0.07	0.04	0.05	0.05
DDA	0.05	0.04	0.02	0.04	0.05	0.06	0.02	0.02
CTA	0.00	0.00	0.25	0.00	0.06	0.00	ND	ND
FPC	ND	ND	ND	ND	ND	ND	ND	ND
DEF	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.05
PPP	ND	ND	ND	ND	ND	ND	ND	ND
RAB	0.00	0.04	0.03	0.00	0.07	0.02	0.04	0.05
TMR	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00
XYZ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CF6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
	Oct-90	Nov-90	Dec-90	Jan-91				
A300								
INDUSTRY	0.00	0.00	0.00	0.12				
ABC	0.00	0.00	0.00	0.17				
CTA	0.00	0.00	0.00	0.00				
XYZ	0.00	0.00	ND	ND				
DDA	0.00	0.00	ND	0.08				
B767								
INDUSTRY	0.04	0.00	0.00	0.00				
DDA	0.03	0.00	ND	0.00				
SSS	ND	ND	ND	ND				
FPC	0.00	0.00	ND	0.00				
GGA	0.00	ND	0.00	ND				
DC10								
INDUSTRY	0.07	0.06	0.07	0.02				
DDA	0.04	0.06	ND	0.00				
CTA	0.00	0.00	0.00	0.00				
FPC	ND	ND	ND	ND				
DEF	0.00	0.00	0.09	0.06				
PPP	ND	ND	ND	ND				
RAB	0.11	ND	0.07	0.03				
TMR	0.00	0.00	0.00	0.00				
XYZ	ND	ND	ND	ND				

CF6 MONTHLY PERFORMANCE			ENGINE REMOVALS					
	Feb-88	Mar-88	Apr-88	May-88	Jun-88	Jul-88	Aug-88	Sep-88
A300								
INDUSTRY	0.46	0.59	0.52	0.54	0.38	0.52	0.81	0.51
ABC	0.35	0.34	0.17	0.17	0.53	0.70	0.18	0.19
CTA	0.19	0.37	0.36	1.01	0.36	0.00	0.18	0.60
XYZ	0.39	0.55	0.51	0.25	0.16	0.48	0.51	0.54
DDA	ND	ND	0.00	0.00	0.00	0.30	0.00	0.00
B767								
INDUSTRY	0.36	0.34	0.15	0.21	0.20	0.25	0.16	0.21
DDA	0.39	0.33	0.10	0.18	0.12	0.23	0.11	0.18
SSS	0.00	0.00	0.00	0.00	0.00	0.00	ND	0.00
FPC	0.16	0.21	0.13	0.13	0.18	0.18	0.12	0.12
GGA	ND	ND	ND	ND	ND	ND	ND	ND
DC10								
INDUSTRY	0.24	0.21	0.22	0.26	0.27	0.26	0.31	0.34
DDA	0.09	0.20	0.17	0.18	0.20	0.18	0.16	0.23
CTA	0.29	0.20	0.07	0.19	0.36	0.28	0.60	0.20
FPC	0.13	0.12	0.27	0.34	0.24	0.23	0.48	1.56
DEF	0.28	0.28	0.17	0.55	0.54	0.94	0.32	0.42
PPP	ND	ND	ND	ND	ND	ND	ND	ND
RAB	0.24	0.13	0.20	0.25	0.17	0.20	0.26	0.36
TMR	0.00	0.32	0.00	ND	0.51	0.00	0.15	0.00
XYZ	1.71	0.65	1.24	0.00	0.00	0.00	0.95	0.00
	Oct-88	Nov-88	Dec-88	Jan-89	Feb-89	Mar-89	Apr-89	May-89
A300								
INDUSTRY	0.29	0.53	0.49	0.41	0.64	0.71	0.28	0.35
ABC	0.39	0.59	0.57	0.00	1.10	0.20	0.21	0.75
CTA	0.00	0.58	0.18	0.19	0.19	0.35	0.18	0.00
XYZ	0.00	0.12	0.22	0.21	0.55	1.71	0.00	0.76
DDA	0.54	0.48	0.56	0.73	0.29	0.65	0.20	0.08
B767								
INDUSTRY	0.36	0.17	0.24	0.23	0.21	0.18	0.40	0.19
DDA	0.11	0.15	0.20	0.11	0.16	0.14	0.29	0.09
SSS	0.29	0.00	0.00	0.24	0.27	0.00	0.00	0.00
FPC	ND	0.12	0.17	0.29	0.13	ND	0.48	0.23
GGA	ND	ND	ND	ND	ND	ND	ND	ND
DC10								
INDUSTRY	0.60	0.25	0.23	0.23	0.27	0.29	0.26	0.25
DDA	0.19	0.25	0.15	0.27	0.34	0.24	0.22	0.31
CTA	0.24	0.40	0.20	0.14	0.44	0.49	0.24	0.05
FPC	ND	0.37	0.00	ND	ND	ND	ND	ND
DEF	0.44	0.00	0.42	0.00	0.35	0.57	0.18	0.09
PPP	ND	ND	ND	ND	ND	ND	ND	0.00
RAB	0.14	0.15	0.21	0.16	0.07	0.18	0.20	0.13
TMR	0.00	0.45	0.00	0.29	0.00	0.00	0.68	0.81
XYZ	0.00	0.00	0.51	0.00	0.00	0.00	0.00	1.24

CF6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
	Jun-89	Jul-89	Aug-89	Sep-89	Oct-89	Nov-89	Dec-89	Jan-90
A300								
INDUSTRY	0.43	0.30	0.44	0.39	0.30	0.51	0.36	0.43
ABC	0.35	0.53	0.18	0.17	0.37	0.21	0.38	0.18
CTA	0.19	0.00	0.17	0.19	0.20	0.00	0.37	0.53
XYZ	1.43	0.00	0.43	0.19	0.33	0.54	0.17	0.37
DDA	0.24	0.22	0.43	0.44	0.08	0.55	0.22	0.30
B767								
INDUSTRY	0.14	0.32	0.40	0.28	0.25	0.19	0.18	0.16
DDA	0.09	0.23	0.37	0.28	0.13	0.11	0.13	0.09
SSS	0.00	ND	ND	ND	ND	ND	ND	ND
FPC	0.13	0.27	0.35	0.13	0.35	0.24	0.18	0.17
GGA	ND	ND	0.00	0.27	0.00	0.00	0.00	0.00
DC10								
INDUSTRY	0.28	0.40	0.23	0.23	0.25	0.22	0.17	0.24
DDA	0.36	0.22	0.21	0.20	0.25	0.17	0.16	0.27
CTA	0.31	0.14	0.14	0.29	0.16	0.06	0.14	0.09
FPC	ND	ND	ND	ND	ND	ND	ND	ND
DEF	0.00	0.18	0.07	0.00	0.05	0.05	0.12	0.00
PPP	0.00	1.00	0.00	0.00	0.00	0.00	ND	ND
RAB	0.15	0.59	0.20	0.15	0.25	0.15	0.12	0.20
TMR	0.35	0.43	0.34	0.38	0.12	0.92	0.14	0.59
XYZ	0.00	0.00	0.00	0.00	0.00	0.88	0.00	0.00
	Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90
A300								
INDUSTRY	0.58	0.49	0.62	0.55	0.44	0.49	0.43	0.26
ABC	0.57	0.55	0.62	ND	0.37	0.37	0.90	0.38
CTA	0.48	0.36	0.25	0.37	0.35	0.53	ND	ND
XYZ	0.97	0.81	0.71	0.00	0.37	1.00	0.17	0.18
DDA	0.18	0.16	0.50	0.63	0.32	0.00	0.15	0.08
B767								
INDUSTRY	0.31	0.32	0.37	0.32	0.36	0.41	0.34	0.23
DDA	0.27	0.29	0.34	0.31	0.29	0.35	0.34	0.21
SSS	ND	ND	ND	ND	ND	ND	ND	ND
FPC	0.13	0.12	0.30	0.18	0.35	0.33	0.28	0.17
GGA	0.28	0.25	0.00	0.00	0.00	0.21	0.00	0.00
DC10								
INDUSTRY	0.25	0.25	0.29	0.28	0.29	0.23	0.32	0.25
DDA	0.26	0.23	0.20	0.28	0.27	0.22	0.36	0.17
CTA	0.24	0.39	0.60	0.20	0.42	0.10	ND	ND
FPC	ND	ND	ND	ND	ND	ND	ND	ND
DEF	0.06	0.12	0.13	0.12	0.07	0.13	0.31	0.18
PPP	ND	ND	ND	ND	ND	ND	ND	ND
RAB	0.17	0.19	0.25	0.24	0.31	0.20	0.25	0.26
TMR	0.38	0.14	0.29	0.54	0.00	0.24	0.20	0.60
XYZ	0.00	0.00	0.00	0.00	0.00	0.00	1.40	0.00

CF6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)							
	Oct-90	Nov-90	Dec-90	Jan-91			
A300							
INDUSTRY	0.52	0.54	0.24	0.44			
ABC	0.19	1.18	0.36	0.17			
CTA	0.50	0.48	0.00	0.34			
XYZ	0.16	0.00	ND	ND			
DDA	0.56	0.25	ND	0.40			
B767							
INDUSTRY	0.19	0.23	0.00	0.16			
DDA	0.11	0.19	ND	0.10			
SSS	ND	ND	ND	ND			
FPC	0.22	0.11	ND	0.11			
GGA	0.00	ND	0.00	ND			
DC10							
INDUSTRY	0.33	0.24	0.29	0.25			
DDA	0.40	0.18	ND	0.19			
CTA	0.13	0.24	0.29	0.13			
FPC	ND	ND	ND	ND			
DEF	0.11	0.16	0.37	0.42			
PPP	ND	ND	ND	ND			
RAB	0.31	ND	0.24	0.24			
TMR	0.00	2.49	0.00	0.09			
XYZ	ND	ND	ND	ND			

PT6 MONTHLY PERFORMANCE			IN FLIGHT SHUTDOWNS					
	Feb-88	Mar-88	Apr-88	May-88	Jun-88	Jul-88	Aug-88	Sep-88
BE 1900								
INDUSTRY	0.00	0.00	0.08	0.16	0.08	0.00	0.00	0.00
GAP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOM	0.00	0.00	0.16	0.32	0.16	ND	ND	ND
TIM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YHS	0.00	ND	ND	0.00	0.00	0.00	0.00	0.00
GLW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CJU	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OTR	ND	ND	0.00	ND	ND	0.00	ND	0.00
NPA	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
PQB	ND	ND	ND	ND	0.00	ND	0.00	0.00
EKV	ND	ND	ND	ND	ND	0.00	0.00	0.00
OSA	ND	ND	ND	ND	ND	ND	ND	ND
CEL	ND	ND	ND	ND	ND	ND	ND	ND
TAM	ND	ND	ND	ND	ND	ND	ND	ND
TMR	ND	ND	ND	ND	ND	ND	ND	ND
AIT	ND	ND	ND	ND	ND	ND	ND	ND
NET	ND	ND	ND	ND	ND	ND	ND	ND
SAB	ND	ND	ND	ND	ND	ND	ND	ND
BAD	ND	ND	ND	ND	ND	ND	ND	ND
NAT	ND	ND	ND	ND	ND	ND	ND	ND
SUB	ND	ND	ND	ND	ND	ND	ND	ND
BE 99								
INDUSTRY	0.14	0.16	0.10	0.00	0.00	0.22	0.21	0.16
AIT	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.64
ARA	0.00	2.45	0.00	0.00	0.00	0.00	0.00	0.00
BID	0.00	0.00	0.00	0.00	0.00	1.12	0.00	0.00
ZMT	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
CAL	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.00
TIM	0.00	0.00	1.15	0.00	0.00	0.00	0.00	0.00
ARE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GEP	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
SUB	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
YHS	0.00	ND	ND	0.00	0.00	0.43	0.82	0.42
BDM	0.00	0.00	0.00	0.00	ND	ND	ND	ND
EMT	0.00	0.00	0.00	0.00	0.00	0.00	ND	0.00
CBP	0.00	0.00	0.00	ND	ND	ND	ND	ND
ARO	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OSA	ND	0.00	0.00	0.00	ND	0.00	0.00	0.00
OTR	ND	ND	0.00	ND	ND	0.00	ND	0.00
SIB	ND	ND	ND	ND	0.00	0.00	0.00	0.00
TEM	ND	ND	ND	ND	ND	ND	ND	ND
JJJ	ND	ND	ND	ND	ND	ND	ND	ND
TUM	ND	ND	ND	ND	ND	ND	ND	ND
CUL	ND	ND	ND	ND	ND	ND	ND	ND
NET	ND	ND	ND	ND	ND	ND	ND	ND
NAT	ND	ND	ND	ND	ND	ND	ND	ND
ESU	ND	ND	ND	ND	ND	ND	ND	ND
BAD	ND	ND	ND	ND	ND	ND	ND	ND
ISA	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
DHC6								
INDUSTRY	0.00	0.29	0.19	0.00	0.10	0.08	0.00	0.00
ARU	0.00	ND	ND	ND	ND	ND	ND	ND
SLP	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00
CPU	0.00	ND	0.00	0.00	0.00	0.00	0.00	ND
BOD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CBA	0.00	ND	0.00	0.00	0.00	0.26	0.00	0.00
LMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOB	0.00	0.00	ND	ND	ND	ND	ND	ND
PMT	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND
FES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NUT	0.00	0.00	ND	ND	0.00	0.00	ND	ND
WGR	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.00
ASI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GUP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AET	0.00	ND	3.13	0.00	0.00	0.00	0.00	0.00
KNY	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00
GOP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QMT	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
NIT	ND	ND	0.00	0.00	0.00	ND	ND	ND
FIS	ND	ND	ND	ND	0.00	0.00	0.00	0.00
BMT	ND	ND	ND	ND	ND	0.00	0.00	0.00
GIP	ND	ND	ND	ND	ND	ND	ND	ND
FAS	ND	ND	ND	ND	ND	ND	ND	ND
CBE	ND	ND	ND	ND	ND	ND	ND	ND
DHC7								
INDUSTRY	0.19	0.15	0.12	0.06	0.06	0.16	0.18	0.22
MAB	0.00	0.44	0.00	0.00	0.00	0.23	0.25	0.53
RCW	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00
CIL	0.23	0.00	0.12	ND	ND	ND	ND	ND
GUP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
AET	2.31	ND	0.00	0.00	0.00	0.00	0.00	0.00
GOP	0.00	0.00	0.00	0.00	0.00	0.70	0.00	0.00
PVK	0.00	0.00	0.00	0.00	0.85	0.00	0.00	0.00
URW	ND	0.17	0.17	0.17	0.00	0.00	0.00	0.17
FUS	ND	ND	ND	0.00	0.00	0.10	0.11	0.11
ARI	ND	ND	ND	ND	ND	ND	ND	ND
BAD	ND	ND	ND	ND	ND	ND	ND	ND
EMB110								
INDUSTRY	0.08	0.08	0.08	0.18	0.08	0.19	0.08	0.15
MAB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEB	0.00	0.00	ND	ND	ND	ND	ND	ND
BED	0.00	ND	0.00	0.00	0.00	0.00	ND	0.00
TUC	0.00	0.00	0.00	0.19	0.10	0.33	0.11	0.12
CAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GEP	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
QXC	0.00	0.22	0.23	0.22	0.00	0.00	0.00	0.00
ASO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NOT	0.61	0.00	0.00	0.00	ND	0.00	ND	ND

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
RMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60
VER	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
CBI	ND	ND	ND	ND	ND	ND	ND	ND
SH SD330								
INDUSTRY	0.08	0.09	0.18	0.00	0.23	0.17	0.30	0.16
ARO	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00
URW	0.00	0.00	0.00	0.00	0.36	0.00	0.00	0.40
IMX	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00
BOD	0.00	0.00	0.75	0.00	0.00	0.79	0.00	0.00
YTZ	0.00	0.00	ND	ND	0.00	ND	ND	0.00
USE	0.00	3.50	0.00	0.00	0.00	0.00	0.00	ND
CJU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAB	0.00	0.00	0.00	0.00	0.38	0.37	0.39	0.00
COL	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.69
EKV	0.00	0.00	0.00	0.00	ND	ND	0.67	0.00
LOZ	0.10	0.09	0.09	0.00	0.18	0.00	ND	ND
TUC	0.00	0.00	1.12	0.00	0.00	0.00	0.46	0.00
ISA	ND	0.00	0.00	ND	0.00	ND	0.55	ND
PQB	ND	0.00	ND	0.00	0.63	ND	0.00	0.00
BUD	ND	ND	ND	ND	ND	ND	ND	ND
	Oct-88	Nov-88	Dec-88	Jan-89	Feb-89	Mar-89	Apr-89	May-89
BE 1900								
INDUSTRY	0.00	0.16	0.10	0.08	0.00	0.00	0.00	0.15
GAP	0.00	0.22	0.20	0.00	0.00	0.00	0.00	0.00
TOM	ND	ND	ND	ND	ND	ND	ND	ND
TIM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YHS	0.00	0.48	0.00	0.50	0.00	0.00	0.00	ND
GLW	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
CJU	ND	0.00	0.00	0.00	0.00	ND	0.00	0.00
OTR	0.00	0.00	ND	ND	0.00	ND	0.00	0.25
NPA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PQB	0.00	1.43	0.00	0.00	0.00	0.00	0.00	0.00
EKV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
OSA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TAM	ND	ND	ND	ND	ND	ND	ND	ND
TMR	ND	ND	ND	0.00	ND	0.00	ND	ND
AIT	ND	ND	ND	ND	ND	ND	ND	83.33
NET	ND	ND	ND	ND	ND	ND	ND	ND
SAB	ND	ND	ND	ND	ND	ND	ND	ND
BAD	ND	ND	ND	ND	ND	ND	ND	ND
NAT	ND	ND	ND	ND	ND	ND	ND	ND
SUB	ND	ND	ND	ND	ND	ND	ND	ND
BE 99								
INDUSTRY	0.10	0.27	0.14	0.00	0.24	0.00	0.14	0.00
AIT	0.00	0.00	0.00	0.00	ND	0.00	0.00	0.00
ARA	0.00	ND	ND	ND	ND	ND	ND	ND
BID	0.00	1.11	0.00	0.00	0.00	ND	ND	0.00

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
ZMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAL	0.56	0.00	0.00	0.00	0.00	0.00	0.00	ND
TIM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ARE	0.00	0.26	0.25	0.00	0.00	ND	0.00	ND
GEP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUB	0.00	1.79	0.00	0.00	0.00	0.00	0.00	0.00
YHS	0.00	0.00	0.00	0.00	0.00	0.00	0.53	ND
BDM	ND	ND	ND	ND	ND	ND	ND	ND
EMT	0.00	0.00	0.00	0.00	0.00	ND	ND	ND
CBP	ND	ND	ND	ND	ND	ND	ND	ND
ARO	0.00	ND	0.00	0.00	0.00	0.00	ND	ND
OSA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OTR	0.00	0.00	ND	ND	1.36	ND	0.00	0.00
SIB	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
TEM	ND	ND	ND	0.00	ND	0.00	0.00	0.00
JJJ	ND	ND	ND	ND	ND	0.00	0.00	ND
TUM	ND	ND	ND	ND	ND	ND	ND	0.00
CUL	ND	ND	ND	ND	ND	ND	ND	ND
NET	ND	ND	ND	ND	ND	ND	ND	ND
NAT	ND	ND	ND	ND	ND	ND	ND	ND
ESU	ND	ND	ND	ND	ND	ND	ND	ND
BAD	ND	ND	ND	ND	ND	ND	ND	ND
ISA	ND	ND	ND	ND	ND	ND	ND	ND
DHC6								
INDUSTRY	0.00	0.00	0.14	0.12	0.12	0.00	0.00	0.10
ARU	ND	ND	ND	ND	ND	ND	ND	ND
SLP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CPU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOD	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
CBA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LMT	0.00	0.00	0.00	0.00	ND	0.00	0.00	0.00
SOB	ND	ND	ND	ND	ND	ND	ND	ND
PMT	ND	ND	ND	ND	ND	ND	ND	ND
FES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NUT	ND	ND	ND	ND	ND	ND	ND	ND
WGR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ASI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GUP	ND	ND	ND	ND	ND	ND	ND	ND
AET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
KNY	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00
GOP	ND	ND	0.87	0.00	0.00	0.00	0.00	ND
QMT	0.00	0.00	ND	ND	ND	ND	ND	ND
NIT	ND	ND	ND	3.97	0.00	0.00	0.00	0.00
FIS	0.00	0.00	0.00	0.00	0.00	ND	0.00	ND
BMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.83
GIP	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
FAS	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
CBE	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
DHC7								
INDUSTRY	0.16	0.26	0.00	0.21	0.12	0.17	0.25	0.00
MAB	0.24	0.24	0.00	0.00	0.00	0.00	0.22	0.00
RCW	0.00	0.21	0.00	0.19	0.24	0.00	0.69	0.00
CIL	ND	ND	ND	ND	ND	ND	ND	ND
GUP	0.00	0.00	ND	0.21	0.00	0.59	0.00	0.00
AET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
GOP	ND	ND	0.00	0.00	0.00	0.00	0.00	ND
PVK	1.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00
URW	0.00	0.23	0.00	0.00	0.00	ND	0.00	0.00
FUS	0.10	0.21	0.00	0.21	0.00	0.00	0.00	ND
ARI	ND	ND	ND	ND	ND	0.00	0.54	0.00
BAD	ND	ND	ND	ND	ND	ND	ND	ND
EMB110								
INDUSTRY	0.15	0.27	0.08	0.15	0.10	0.00	0.00	0.14
MAB	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00
SEB	ND	ND	ND	ND	ND	ND	ND	ND
BED	0.00	0.00	0.00	0.91	0.50	0.00	0.00	0.00
TUC	0.12	0.36	0.12	0.00	0.00	0.00	0.00	0.19
CAL	0.00	0.00	0.00	0.00	ND	ND	ND	ND
GEP	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
QXC	0.22	0.23	0.00	0.00	0.00	0.00	0.00	0.00
ASO	0.00	0.00	0.00	0.00	ND	ND	ND	ND
NOT	ND	ND	ND	ND	ND	ND	ND	ND
RMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VER	0.00	0.00	0.00	0.00	ND	ND	ND	ND
CBI	ND	ND	ND	ND	ND	ND	ND	ND
SH SD330								
INDUSTRY	0.06	0.00	0.18	0.00	0.08	0.00	0.00	0.24
ARO	0.00	ND	0.00	0.00	0.00	0.00	ND	ND
URW	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
IMX	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38
BOD	0.72	0.00	ND	0.00	0.00	0.00	0.00	0.00
YTZ	ND	ND	ND	0.00	0.00	0.00	0.00	ND
USE	0.00	0.00	2.54	0.00	0.00	ND	ND	ND
CJU	ND	0.00	0.00	0.00	0.00	ND	0.00	0.00
MAB	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND
COL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EKV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
LOZ	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.19
TUC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ISA	0.00	ND	0.26	0.00	0.28	0.00	ND	ND
PQB	0.00	0.00	0.00	0.00	ND	ND	ND	ND
BUD	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
	Jun-89	Jul-89	Aug-89	Sep-89	Oct-89	Nov-89	Dec-89	Jan-90
BE 1900								
INDUSTRY	0.23	0.20	0.00	0.10	0.08	0.12	0.14	0.06
GAP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23
TOM	ND	ND	ND	ND	ND	ND	ND	ND
TIM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
YHS	0.00	ND	0.00	0.00	0.00	ND	0.00	0.00
GLW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CJU	0.26	0.00	0.00	0.00	0.00	0.00	ND	0.00
OTR	0.25	0.00	0.00	0.54	0.00	0.28	0.28	0.00
NPA	0.54	0.29	0.00	0.00	0.00	0.00	0.34	0.00
PQB	0.49	1.42	0.00	0.00	0.86	0.00	0.00	0.00
EKV	0.00	0.00	0.00	0.00	0.00	0.18	0.18	0.00
OSA	0.00	0.00	0.00	ND	0.00	0.00	ND	0.00
CEL	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND
TAM	ND	ND	ND	ND	ND	ND	ND	0.00
TMR	ND	0.00	ND	ND	ND	ND	ND	0.00
AIT	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
NET	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
SAB	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
BAD	ND	ND	ND	ND	ND	ND	ND	ND
NAT	ND	ND	ND	ND	ND	ND	ND	0.00
SUB	ND	ND	ND	ND	ND	ND	ND	ND
BE 99								
INDUSTRY	0.14	0.00	0.22	0.16	0.00	0.00	0.00	0.16
AIT	0.00	0.00	0.00	ND	ND	ND	ND	ND
ARA	ND	ND	ND	ND	ND	ND	ND	ND
BID	0.00	0.00	0.00	ND	ND	ND	ND	ND
ZMT	ND	ND	ND	ND	ND	ND	ND	ND
CAL	ND	ND	ND	ND	ND	ND	ND	ND
TIM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ARE	ND	ND	ND	ND	ND	ND	ND	ND
GEP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
SUB	0.00	0.00	0.00	0.00	0.00	ND	0.00	1.24
YHS	0.00	ND	0.00	1.41	0.00	ND	ND	ND
BDM	ND	ND	ND	ND	ND	ND	ND	ND
EMT	ND	ND	ND	ND	ND	ND	ND	ND
CBP	ND	ND	ND	ND	ND	ND	ND	ND
ARO	0.00	0.00	ND	0.00	0.00	ND	ND	0.00
OSA	0.00	0.00	0.00	ND	0.00	0.00	ND	0.00
OTR	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SIB	0.00	0.00	2.06	0.00	0.00	0.00	0.00	0.00
TEM	0.00	0.00	0.00	ND	0.00	0.00	0.00	ND
JJJ	ND	ND	ND	ND	ND	ND	ND	ND
TUM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CUL	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
NET	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
NAT	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
ESU	ND	ND	ND	ND	ND	ND	ND	0.00
BAD	ND	ND	ND	ND	ND	ND	ND	ND
ISA	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
DHC6								
INDUSTRY	0.17	0.14	0.10	0.10	0.00	0.00	0.12	0.00
ARU	ND	ND	ND	ND	ND	ND	ND	ND
SLP	0.00	0.00	0.00	0.40	0.00	0.00	0.00	0.00
CPU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CBA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOB	ND	ND	ND	ND	ND	ND	ND	ND
PMT	ND	ND	ND	ND	ND	ND	ND	ND
FES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IET	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
NUT	ND	ND	ND	ND	ND	ND	ND	ND
WGR	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00
ASI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GUP	ND	ND	ND	ND	ND	ND	ND	ND
AET	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
KNY	0.40	ND	0.00	0.00	0.00	0.00	0.00	0.00
GOP	0.00	0.00	ND	0.00	0.00	0.00	1.14	0.00
QMT	ND	ND	ND	ND	ND	ND	ND	ND
NIT	0.00	0.00	0.00	ND	0.00	ND	0.00	ND
FIS	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
BMT	0.00	0.00	1.34	0.00	0.00	0.00	0.00	0.00
GIP	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND
FAS	0.00	0.00	0.00	ND	0.00	ND	0.00	0.00
CBE	ND	ND	ND	ND	ND	ND	ND	0.00
DHC7								
INDUSTRY	0.00	0.00	0.25	0.00	0.32	0.00	0.12	0.12
MAB	ND	ND	ND	ND	ND	ND	0.00	0.00
RCW	0.00	0.00	0.45	0.00	0.48	0.00	0.00	0.00
CIL	ND	ND	ND	ND	ND	ND	ND	ND
GUP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28
AET	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
GOP	ND	ND	ND	ND	ND	ND	ND	ND
PVK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
URW	0.00	0.00	0.23	0.00	0.00	0.00	0.00	0.27
FUS	0.00	0.00	0.18	0.00	0.40	0.00	0.00	0.00
ARI	0.00	0.00	0.00	0.00	0.00	0.00	0.70	0.00
BAD	ND	ND	ND	ND	ND	ND	ND	ND
EMB110								
INDUSTRY	0.00	0.00	0.14	0.00	0.16	0.00	0.00	0.21
MAB	ND	ND	ND	ND	ND	ND	0.00	0.00
SEB	ND	ND	ND	ND	ND	ND	ND	ND
BED	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
TUC	0.00	0.00	0.10	0.00	0.13	0.00	0.00	0.14
CAL	ND	ND	ND	ND	ND	ND	ND	ND
GEP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
QXC	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
ASO	ND	ND	ND	ND	ND	ND	ND	ND
NOT	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
RMT	0.00	0.00	ND	ND	ND	ND	ND	ND
VER	ND	ND	ND	ND	ND	ND	ND	ND
CBI	ND	ND	ND	ND	ND	ND	ND	ND
SH SD330								
INDUSTRY	0.06	0.18	0.21	0.08	0.06	0.08	0.18	0.00
ARO	0.00	0.00	ND	ND	ND	ND	ND	ND
URW	ND	ND	ND	ND	ND	ND	ND	ND
IMX	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00
BOD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YTZ	0.00	0.00	0.00	ND	0.00	ND	0.00	0.00
USE	0.00	ND	ND	0.00	0.00	0.00	ND	ND
CJU	0.76	0.77	0.00	0.00	0.00	0.00	ND	0.00
MAB	ND	ND	ND	ND	ND	ND	ND	ND
COL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EKV	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00
LOZ	0.00	0.09	0.26	0.09	0.00	0.10	0.10	0.00
TUC	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00
ISA	0.00	ND	ND	ND	ND	ND	ND	ND
PQB	ND	ND	ND	ND	ND	ND	ND	ND
BUD	ND	ND	ND	ND	ND	ND	ND	ND
	Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90
BE 1900								
INDUSTRY	0.10	0.09	0.12	0.00	0.04	0.07	0.00	0.18
GAP	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOM	ND	ND	ND	ND	ND	ND	ND	ND
TIM	0.00	ND	0.30	0.00	0.00	0.00	0.00	0.00
YHS	0.00	0.00	0.00	0.00	0.12	0.00	0.00	ND
GLW	0.00	0.00	ND	ND	ND	ND	ND	ND
CJU	0.36	0.31	0.59	ND	0.00	0.00	0.00	0.22
OTR	0.00	0.00	ND	0.00	0.00	ND	0.00	1.34
NPA	0.00	0.00	0.00	0.00	ND	0.00	0.00	ND
PQB	0.00	ND	0.00	0.00	0.00	0.31	0.00	0.00
EKV	0.00	0.16	0.00	0.00	0.00	0.22	0.00	0.24
OSA	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
CEL	ND	ND	ND	ND	ND	ND	ND	ND
TAM	ND	ND	ND	ND	ND	ND	ND	ND
TMR	ND	ND	ND	ND	0.00	0.00	0.00	0.00
AIT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NET	ND	0.00	0.00	0.00	0.00	0.00	0.00	ND
SAB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BAD	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
NAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUB	ND	ND	ND	ND	ND	ND	ND	0.00
BE 99								
INDUSTRY	0.20	0.00	0.00	0.18	0.20	0.00	0.16	0.20
AIT	ND	ND	ND	ND	ND	ND	ND	ND
ARA	ND	ND	ND	ND	ND	ND	ND	ND
BID	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
ZMT	ND	ND	ND	ND	ND	ND	ND	ND
CAL	ND	ND	ND	ND	ND	ND	ND	ND
TIM	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
ARE	ND	ND	ND	ND	ND	ND	ND	ND
GEP	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
SUB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YHS	ND	ND	ND	ND	ND	ND	ND	ND
BDM	ND	ND	ND	ND	ND	ND	ND	ND
EMT	ND	ND	ND	ND	ND	ND	ND	ND
CBP	ND	ND	ND	ND	ND	ND	ND	ND
ARO	0.00	0.00	0.00	0.00	ND	0.00	0.00	0.00
OSA	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
OTR	0.00	0.00	ND	0.19	0.00	ND	0.00	0.00
SIB	0.00	0.00	ND	ND	ND	ND	ND	ND
TEM	ND	0.00	0.00	ND	ND	ND	ND	0.00
JJJ	ND	ND	ND	ND	ND	ND	ND	ND
TUM	0.00	0.00	0.00	0.00	2.11	0.00	0.00	2.14
CUL	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
NET	ND	0.00	0.00	0.00	0.00	0.00	0.00	ND
NAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ESU	3.68	ND	0.00	0.00	0.00	0.00	ND	ND
BAD	ND	ND	ND	ND	ND	ND	0.44	0.00
ISA	ND	ND	ND	ND	ND	ND	0.00	ND
DHC6								
INDUSTRY	0.14	0.10	0.00	0.00	0.00	0.17	0.00	0.14
ARU	ND	ND	ND	ND	ND	ND	ND	ND
SLP	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
CPU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOD	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
CBA	0.00	0.00	ND	0.00	0.00	0.25	0.00	ND
LMT	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOB	ND	ND	ND	ND	ND	ND	ND	ND
PMT	ND	ND	ND	ND	ND	ND	ND	ND
FES	0.00	0.00	0.00	0.00	ND	ND	ND	ND
IET	ND	0.00	0.00	0.00	ND	0.00	0.00	0.00
NUT	ND	ND	ND	ND	ND	ND	ND	ND
WGR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26
ASI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GUP	ND	ND	ND	ND	ND	ND	ND	ND
AET	0.00	0.00	0.00	0.00	0.00	3.68	0.00	ND
KNY	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
GOP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QMT	ND	ND	ND	ND	ND	ND	ND	ND
NIT	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FIS	0.00	ND	ND	0.00	ND	ND	ND	ND
BMT	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
GIP	0.00	0.00	0.00	ND	0.00	0.00	ND	ND
FAS	0.00	ND	ND	0.00	0.00	0.00	0.00	ND
CBE	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
DHC7								
INDUSTRY	0.08	0.00	0.08	0.00	0.08	0.08	0.00	0.15
MAB	0.00	0.00	0.00	0.00	0.00	0.59	0.00	0.00
RCW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73
CIL	ND	ND	ND	ND	ND	ND	ND	ND
GUP	0.30	0.00	ND	ND	ND	ND	ND	ND
AET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
GOP	ND	ND	ND	ND	ND	ND	ND	ND
PVK	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
URW	0.00	0.00	0.00	0.00	0.00	ND	0.00	ND
FUS	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00
ARI	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00
BAD	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
EMB110								
INDUSTRY	0.14	0.00	0.20	0.37	0.30	0.12	0.22	0.24
MAB	0.00	0.00	0.18	0.36	0.00	0.18	0.17	0.37
SEB	ND	ND	ND	ND	ND	ND	ND	ND
BED	ND	ND	ND	ND	ND	0.00	ND	ND
TUC	0.16	0.00	0.00	0.00	0.15	0.00	0.17	0.00
CAL	ND	ND	ND	ND	ND	ND	ND	ND
GEP	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
QXC	0.00	0.00	0.26	0.00	0.58	0.00	0.00	0.00
ASO	ND	ND	ND	ND	ND	ND	ND	ND
NOT	ND	ND	ND	ND	ND	ND	ND	ND
RMT	ND	ND	ND	ND	ND	ND	ND	ND
VER	ND	ND	ND	ND	ND	ND	ND	ND
CBI	ND	ND	ND	ND	0.00	0.00	0.00	0.00
SH SD330								
INDUSTRY	0.15	0.00	0.17	0.00	0.13	0.00	0.00	0.22
ARO	ND	ND	ND	ND	ND	ND	ND	ND
URW	ND	ND	ND	ND	ND	ND	ND	ND
IMX	0.21	0.00	0.00	0.00	0.37	0.00	0.00	0.00
BOD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.97
YTZ	ND	0.00	ND	ND	ND	ND	0.00	ND
USE	ND	ND	ND	ND	ND	0.00	0.00	ND
CJU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MAB	ND	ND	ND	ND	ND	ND	ND	ND
COL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EKV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LOZ	0.11	0.00	0.28	0.00	0.00	0.00	0.00	0.27
TUC	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
ISA	ND	ND	ND	ND	ND	ND	0.00	0.00
PQB	ND	ND	ND	ND	ND	ND	ND	ND
BUD	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)								
	Oct-90	Nov-90	Dec-90	Jan-91				
BE 1900								
INDUSTRY	0.09	0.15	0.13	0.04				
GAP	0.00	0.00	0.00	0.00				
TOM	ND	ND	ND	ND				
TIM	0.00	0.00	0.00	0.00				
YHS	0.00	0.00	0.00	0.00				
GLW	ND	ND	ND	ND				
CJU	0.00	0.00	0.60	0.00				
OTR	ND	0.74	0.00	0.00				
NPA	0.00	0.00	0.00	0.00				
PQB	0.00	0.31	0.24	0.00				
EKV	0.43	0.00	0.00	0.00				
OSA	2.02	0.00	ND	ND				
CEL	ND	ND	ND	ND				
TAM	ND	ND	ND	ND				
TMR	0.00	ND	ND	0.00				
AIT	0.00	0.00	0.00	0.00				
NET	0.00	0.00	0.00	0.00				
SAB	0.00	0.00	0.00	0.00				
BAD	0.00	0.00	0.00	0.00				
NAT	0.00	0.82	0.00	0.82				
SUB	0.00	4.20	0.00	0.00				
BE 99								
INDUSTRY	0.00	0.00	0.00	0.00				
AIT	ND	ND	ND	ND				
ARA	ND	ND	ND	ND				
BID	ND	ND	ND	ND				
ZMT	ND	ND	ND	ND				
CAL	ND	ND	ND	ND				
TIM	0.00	0.00	0.00	0.00				
ARE	ND	ND	ND	ND				
GEP	ND	0.00	0.00	0.00				
SUB	0.00	0.00	0.00	0.00				
YHS	ND	ND	ND	ND				
BDM	ND	ND	ND	ND				
EMT	ND	ND	ND	ND				
CBP	ND	ND	ND	ND				
ARO	0.00	0.00	0.00	ND				
OSA	ND	0.00	ND	ND				
OTR	ND	0.00	0.00	0.00				
SIB	ND	ND	ND	ND				
TEM	ND	0.00	0.00	0.00				
JJJ	ND	ND	ND	ND				
TUM	0.00	0.00	0.00	0.00				
CUL	0.00	ND	ND	ND				
NET	0.00	0.00	0.00	0.00				
NAT	0.00	0.00	0.00	0.00				
ESU	0.00	0.00	0.00	0.00				
BAD	0.00	0.00	0.00	0.00				
ISA	ND	0.00	ND	ND				

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)							
DHC6							
INDUSTRY	0.10	0.22	0.16	0.16			
ARU	ND	ND	ND	ND			
SLP	0.00	0.00	0.00	0.00			
CPU	0.00	0.00	0.00	0.00			
BOD	ND	0.00	0.00	0.00			
CBA	0.00	0.00	ND	0.00			
LMT	0.00	0.00	0.00	0.00			
SOB	ND	ND	ND	ND			
PMT	ND	ND	ND	ND			
FES	ND	ND	ND	ND			
IET	0.00	0.00	0.00	0.00			
NUT	ND	ND	ND	ND			
WGR	0.00	0.27	0.26	0.32			
ASI	0.00	0.00	0.00	0.00			
GUP	ND	ND	ND	ND			
AET	0.00	0.00	0.00	0.00			
KNY	0.19	0.26	0.00	0.00			
GOP	0.00	ND	ND	ND			
QMT	ND	ND	ND	ND			
NIT	0.00	0.00	0.00	0.00			
FIS	0.00	ND	0.00	ND			
BMT	0.00	0.00	0.00	0.00			
GIP	ND	ND	ND	ND			
FAS	0.00	ND	ND	ND			
CBE	0.00	0.00	0.00	0.00			
DHC7							
INDUSTRY	0.20	0.08	0.10	0.00			
MAB	0.54	0.00	0.00	0.00			
RCW	0.34	0.00	0.33	0.00			
CIL	ND	ND	ND	ND			
GUP	ND	ND	ND	ND			
AET	0.00	0.00	0.00	0.00			
GOP	ND	ND	ND	ND			
PVK	0.00	0.00	0.00	0.00			
URW	ND	0.00	0.00	0.00			
FUS	0.10	0.13	0.00	0.00			
ARI	0.00	0.00	0.00	0.00			
BAD	0.00	0.00	0.00	0.00			
EMB110							
INDUSTRY	0.14	0.18	0.20	0.00			
MAB	0.00	0.18	0.20	0.00			
SEB	ND	ND	ND	ND			
BED	ND	ND	ND	ND			
TUC	0.24	0.00	0.00	0.00			
CAL	ND	ND	ND	ND			
GEP	ND	0.00	0.00	0.00			
OXC	0.00	0.00	0.00	0.00			
ASO	ND	ND	ND	ND			
NOT	ND	ND	ND	ND			

PT6 MONTHLY PERFORMANCE IN-FLIGHT SHUTDOWNS (CONTINUED)							
RMT	ND	ND	ND	ND			
VER	ND	ND	ND	ND			
CBI	0.00	0.00	0.00	0.00			
SH SD330							
INDUSTRY	0.00	0.16	0.14	0.18			
ARO	ND	ND	ND	ND			
URW	ND	ND	ND	ND			
IMX	0.00	0.00	0.18	0.13			
BOD	ND	0.00	0.00	0.00			
YTZ	ND	ND	ND	ND			
USE	0.00	0.00	3.09	0.00			
CJU	0.00	0.00	0.00	0.00			
MAB	ND	ND	ND	ND			
COL	0.00	ND	ND	ND			
EKV	0.00	0.00	0.00	0.30			
LOZ	0.00	0.18	0.00	0.09			
TUC	0.00	0.00	0.00	0.00			
ISA	ND	0.25	ND	ND			
PQB	ND	ND	ND	ND			
BUD	ND	ND	ND	0.00			

PT6 MONTHLY PERFORMANCE			ENGINE REMOVALS					
	Feb-88	Mar-88	Apr-88	May-88	Jun-88	Jul-88	Aug-88	Sep-88
BE 1900								
INDUSTRY	0.00	0.10	0.00	0.00	0.08	0.13	0.00	0.14
GAP	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00
TOM	0.00	0.16	0.00	0.00	0.16	ND	ND	ND
TIM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YHS	0.00	ND	ND	0.00	0.00	0.00	0.00	0.00
GLW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
CJU	ND	0.00	0.00	0.00	0.00	0.25	0.00	0.00
OTR	ND	ND	0.00	ND	ND	0.00	ND	0.43
NPA	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
PQB	ND	ND	ND	ND	0.00	ND	0.00	0.00
EKV	ND	ND	ND	ND	ND	0.00	0.00	0.00
OSA	ND	ND	ND	ND	ND	ND	ND	ND
CEL	ND	ND	ND	ND	ND	ND	ND	ND
TAM	ND	ND	ND	ND	ND	ND	ND	ND
TMR	ND	ND	ND	ND	ND	ND	ND	ND
AIT	ND	ND	ND	ND	ND	ND	ND	ND
NET	ND	ND	ND	ND	ND	ND	ND	ND
SAB	ND	ND	ND	ND	ND	ND	ND	ND
BAD	ND	ND	ND	ND	ND	ND	ND	ND
NAT	ND	ND	ND	ND	ND	ND	ND	ND
SUB	ND	ND	ND	ND	ND	ND	ND	ND
BE 99								
INDUSTRY	0.14	0.38	0.30	0.00	0.14	0.16	0.21	0.28
AIT	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.64
ARA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BID	0.00	0.00	1.28	0.00	0.00	1.12	0.00	0.99
ZMT	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
CAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TIM	0.00	0.00	1.15	0.00	0.00	0.00	0.00	0.00
ARE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GEP	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
SUB	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
YHS	0.00	ND	ND	0.00	0.00	0.43	0.82	0.42
BDM	0.00	0.00	0.00	0.00	ND	ND	ND	ND
EMT	1.27	0.00	0.00	0.00	0.00	0.00	ND	0.00
CBP	0.00	1.78	0.83	ND	ND	ND	ND	ND
ARO	ND	1.07	0.00	0.00	0.00	0.00	0.00	0.00
OSA	ND	0.00	0.00	0.00	ND	0.00	0.00	0.00
OTR	ND	ND	0.00	ND	ND	0.00	ND	0.00
SIB	ND	ND	ND	ND	0.90	0.00	0.00	1.07
TEM	ND	ND	ND	ND	ND	ND	ND	ND
JJJ	ND	ND	ND	ND	ND	ND	ND	ND
TUM	ND	ND	ND	ND	ND	ND	ND	ND
CUL	ND	ND	ND	ND	ND	ND	ND	ND
NET	ND	ND	ND	ND	ND	ND	ND	ND
NAT	ND	ND	ND	ND	ND	ND	ND	ND
ESU	ND	ND	ND	ND	ND	ND	ND	ND
BAD	ND	ND	ND	ND	ND	ND	ND	ND
ISA	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
DHC6								
INDUSTRY	0.12	0.21	0.25	0.24	0.16	0.14	0.10	0.19
ARU	0.00	ND	ND	ND	ND	ND	ND	ND
SLP	0.60	0.44	0.00	0.49	0.00	0.00	0.00	0.00
CPU	0.00	ND	0.00	0.00	0.00	0.00	0.00	ND
BOD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CBA	0.00	ND	0.00	0.00	0.00	0.26	0.00	0.00
LMT	0.00	0.00	0.00	0.00	0.00	0.00	2.35	0.00
SOB	0.00	0.00	ND	ND	ND	ND	ND	ND
PMT	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND
FES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NUT	0.00	0.00	ND	ND	0.00	0.00	ND	ND
WGR	0.00	0.00	1.41	0.42	0.00	0.00	0.00	0.00
ASI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GUP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
AET	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
KNY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GOP	0.00	0.63	0.00	0.65	1.30	0.60	0.00	1.26
QMT	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
NIT	ND	ND	0.00	0.00	0.00	ND	ND	ND
FIS	ND	ND	ND	ND	0.00	0.00	0.00	0.00
BMT	ND	ND	ND	ND	ND	0.00	0.00	0.00
GIP	ND	ND	ND	ND	ND	ND	ND	ND
FAS	ND	ND	ND	ND	ND	ND	ND	ND
CBE	ND	ND	ND	ND	ND	ND	ND	ND
DHC7								
INDUSTRY	0.47	0.46	0.28	0.54	0.40	0.68	0.26	0.52
MAB	0.55	0.87	0.44	1.35	0.24	0.68	0.51	1.06
RCW	0.97	0.75	0.39	0.59	0.80	0.77	0.55	0.58
CIL	0.23	0.00	0.12	ND	ND	ND	ND	ND
GUP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
AET	0.00	ND	0.00	1.27	1.13	0.00	0.00	2.06
GOP	0.00	0.00	0.00	0.81	0.68	2.11	0.00	0.00
PVK	0.00	0.00	0.00	0.00	0.00	0.85	0.00	0.00
URW	ND	0.51	0.17	0.17	0.18	0.63	0.17	0.17
FUS	ND	ND	ND	0.12	0.12	0.31	0.00	0.22
ARI	ND	ND	ND	ND	ND	ND	ND	ND
BAD	ND	ND	ND	ND	ND	ND	ND	ND
EMB110								
INDUSTRY	0.19	0.08	0.43	0.37	0.32	0.08	0.31	0.21
MAB	0.31	0.00	0.99	0.46	0.49	0.17	0.50	0.53
SEB	0.00	0.00	ND	ND	ND	ND	ND	ND
BED	0.00	ND	0.00	0.00	0.00	0.00	ND	0.00
TUC	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00
CAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GEP	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
QXC	0.00	0.00	0.46	0.67	0.22	0.00	0.22	0.00
ASO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NOT	0.61	0.51	0.00	0.00	ND	0.00	ND	ND

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
RMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VER	ND	ND	ND	1.98	1.82	0.00	0.00	0.00
CBI	ND	ND	ND	ND	ND	ND	ND	ND
SH SD330								
INDUSTRY	0.12	0.28	0.37	0.43	0.23	0.44	0.46	0.16
ARO	ND	0.00	1.65	0.00	0.00	1.50	4.70	0.00
URW	ND	0.63	0.37	0.00	0.00	0.71	0.00	0.40
IMX	0.33	0.00	0.79	0.00	0.00	0.31	0.00	0.00
BOD	0.00	0.00	0.75	0.00	0.00	0.79	0.00	0.00
YTZ	0.00	0.00	ND	ND	0.00	ND	ND	0.00
USE	0.00	0.00	0.00	3.52	0.00	0.00	0.00	ND
CJU	0.00	0.75	0.34	0.41	0.00	0.41	0.00	0.00
MAB	0.00	0.30	0.35	0.36	0.00	0.37	0.77	0.41
COL	0.00	0.00	0.00	0.54	0.00	0.00	0.57	0.00
EKV	0.00	0.00	0.00	0.72	ND	ND	0.00	0.00
LOZ	0.61	0.27	0.18	0.44	0.54	0.09	ND	ND
TUC	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.00
ISA	ND	0.00	0.00	ND	0.00	ND	0.55	ND
PQB	ND	0.00	ND	0.00	0.00	ND	0.00	0.00
BUD	ND	ND	ND	ND	ND	ND	ND	ND
	Oct-88	Nov-88	Dec-88	Jan-89	Feb-89	Mar-89	Apr-89	May-89
BE 1900								
INDUSTRY	0.00	0.12	0.10	0.14	0.12	0.00	0.06	0.15
GAP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOM	ND	ND	ND	ND	ND	ND	ND	ND
TIM	0.00	0.00	0.00	1.36	0.00	0.00	1.20	0.00
YHS	0.00	0.48	0.00	0.50	0.00	0.00	0.00	ND
GLW	0.00	0.00	ND	0.00	0.57	0.00	0.00	0.00
CJU	ND	0.00	0.00	0.00	0.00	ND	0.00	0.00
OTR	0.00	0.00	ND	ND	0.00	ND	0.00	0.25
NPA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PQB	0.00	1.43	0.00	0.00	0.00	0.00	0.00	0.00
EKV	0.00	0.00	0.19	0.00	0.00	0.00	0.00	ND
OSA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CEL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TAM	ND	ND	ND	ND	ND	ND	ND	ND
TMR	ND	ND	ND	0.00	ND	0.00	ND	ND
AIT	ND	ND	ND	ND	ND	ND	ND	83.33
NET	ND	ND	ND	ND	ND	ND	ND	ND
SAB	ND	ND	ND	ND	ND	ND	ND	ND
BAD	ND	ND	ND	ND	ND	ND	ND	ND
NAT	ND	ND	ND	ND	ND	ND	ND	ND
SUB	ND	ND	ND	ND	ND	ND	ND	ND
BE 99								
INDUSTRY	0.16	0.34	0.14	0.27	0.00	0.32	0.51	0.18
AIT	0.00	0.00	0.00	0.00	ND	0.76	0.00	0.00
ARA	0.00	ND	ND	ND	ND	ND	ND	ND
BID	1.02	1.11	0.00	1.60	0.00	ND	ND	0.00

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
ZMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
TIM	0.60	0.00	0.71	0.00	0.00	0.00	0.00	0.00
ARE	0.00	0.26	0.00	0.00	0.00	ND	0.00	ND
GEP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUB	0.00	3.57	0.00	0.00	0.00	0.00	0.00	0.00
YHS	0.00	0.00	0.00	0.00	0.00	0.00	1.05	ND
BDM	ND	ND	ND	ND	ND	ND	ND	ND
EMT	0.00	0.00	0.00	0.96	0.00	ND	ND	ND
CBP	ND	ND	ND	ND	ND	ND	ND	ND
ARO	0.00	ND	0.00	0.00	0.00	1.29	ND	ND
OSA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OTR	0.00	0.00	ND	ND	0.00	ND	0.00	0.00
SIB	0.00	ND	0.00	0.00	0.00	0.00	2.11	0.91
TEM	ND	ND	ND	0.00	ND	0.00	0.00	0.00
JJJ	ND	ND	ND	ND	ND	0.00	0.83	ND
TUM	ND	ND	ND	ND	ND	ND	ND	0.00
CUL	ND	ND	ND	ND	ND	ND	ND	ND
NET	ND	ND	ND	ND	ND	ND	ND	ND
NAT	ND	ND	ND	ND	ND	ND	ND	ND
ESU	ND	ND	ND	ND	ND	ND	ND	ND
BAD	ND	ND	ND	ND	ND	ND	ND	ND
ISA	ND	ND	ND	ND	ND	ND	ND	ND
DHC6								
INDUSTRY	0.36	0.14	0.14	0.22	0.00	0.18	0.00	0.25
ARU	ND	ND	ND	ND	ND	ND	ND	ND
SLP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41
CPU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOD	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
CBA	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.29
LMT	0.00	0.00	0.00	0.00	ND	0.00	0.00	0.00
SOB	ND	ND	ND	ND	ND	ND	ND	ND
PMT	ND	ND	ND	ND	ND	ND	ND	ND
FES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NUT	ND	ND	ND	ND	ND	ND	ND	ND
WGR	0.37	0.00	0.00	0.38	0.00	0.32	0.00	0.35
ASI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GUP	ND	ND	ND	ND	ND	ND	ND	ND
AET	3.36	0.00	0.00	0.00	0.00	0.00	0.00	ND
KNY	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00
GOP	ND	ND	0.87	0.00	0.00	0.00	0.00	ND
QMT	0.00	0.00	ND	ND	ND	ND	ND	ND
NIT	ND	ND	ND	3.97	0.00	0.00	0.00	0.00
FIS	0.00	0.00	0.00	0.00	0.00	ND	0.00	ND
BMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GIP	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
FAS	ND	ND	ND	0.00	0.00	2.04	0.00	0.00
CBE	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
DHC7								
INDUSTRY	0.52	0.60	0.57	0.37	0.36	0.58	0.53	0.36
MAB	0.95	0.73	0.53	0.25	0.00	0.21	0.65	0.42
RCW	0.59	1.06	0.84	0.58	1.19	1.07	1.15	0.64
CIL	ND	ND	ND	ND	ND	ND	ND	ND
GUP	0.00	0.00	ND	0.00	0.24	0.79	0.00	0.00
AET	0.90	0.00	0.00	0.00	0.00	0.00	0.00	ND
GOP	ND	ND	6.76	0.00	0.00	0.00	0.00	ND
PVK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
URW	0.17	0.46	0.00	0.25	0.26	ND	0.24	0.00
FUS	0.30	0.31	0.32	0.32	0.00	0.20	0.34	ND
ARI	ND	ND	ND	ND	ND	0.00	0.00	0.00
BAD	ND	ND	ND	ND	ND	ND	ND	ND
EMB110								
INDUSTRY	0.32	0.27	0.00	0.15	0.10	0.51	0.38	0.20
MAB	0.84	0.00	0.00	0.35	0.19	0.83	0.35	0.33
SEB	ND	ND	ND	ND	ND	ND	ND	ND
BED	0.00	0.00	0.00	0.00	0.00	0.00	2.37	0.79
TUC	0.00	0.24	0.00	0.00	0.00	0.20	0.11	0.00
CAL	0.00	0.00	0.00	0.00	ND	ND	ND	ND
GEP	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
QXC	0.00	0.46	0.00	0.00	0.00	0.44	0.00	0.00
ASO	0.00	0.00	0.00	0.00	ND	ND	ND	ND
NOT	ND	ND	ND	ND	ND	ND	ND	ND
RMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VER	0.00	0.00	0.00	0.00	ND	ND	ND	ND
CBI	ND	ND	ND	ND	ND	ND	ND	ND
SH SD330								
INDUSTRY	0.25	0.24	0.18	0.21	0.17	0.12	0.13	0.36
ARO	0.00	ND	0.00	0.00	0.00	0.00	ND	ND
URW	0.48	0.00	0.00	0.00	0.00	ND	0.00	0.00
IMX	0.73	0.45	0.00	0.00	0.00	0.41	0.57	0.00
BOD	0.72	0.00	ND	0.00	0.00	0.00	0.00	0.00
YTZ	ND	ND	ND	0.00	0.00	0.00	0.00	ND
USE	0.00	0.00	0.00	0.00	3.03	ND	ND	ND
CJU	ND	0.74	0.35	0.00	0.00	ND	0.00	0.00
MAB	0.37	0.00	0.00	0.77	1.60	0.00	ND	ND
COL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66
EKV	0.00	0.00	0.00	0.00	0.00	0.41	0.00	ND
LOZ	0.00	0.00	0.11	0.26	0.13	0.00	0.09	0.38
TUC	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00
ISA	0.23	ND	0.26	0.29	0.00	0.00	ND	ND
PQB	0.00	0.00	0.00	0.00	ND	ND	ND	ND
BUD	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
	Jun-89	Jul-89	Aug-89	Sep-89	Oct-89	Nov-89	Dec-89	Jan-90
BE 1900								
INDUSTRY	0.23	0.16	0.16	0.10	0.14	0.16	0.18	0.09
GAP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23
TOM	ND	ND	ND	ND	ND	ND	ND	ND
TIM	0.00	0.00	0.00	0.56	0.00	0.00	0.00	ND
YHS	0.00	ND	0.00	0.00	0.00	ND	0.00	0.00
GLW	0.51	0.00	0.90	0.00	0.35	0.25	0.00	0.00
CJU	0.00	0.26	0.00	0.00	0.00	0.28	ND	0.00
OTR	0.00	0.00	0.00	0.27	0.00	0.00	0.28	0.00
NPA	0.54	0.29	0.00	0.00	0.00	0.00	0.68	0.00
PQB	0.49	0.47	0.00	0.00	0.86	0.00	0.00	0.41
EKV	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00
OSA	0.00	0.00	0.00	ND	0.00	0.00	ND	0.00
CEL	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND
TAM	ND	ND	ND	ND	ND	ND	ND	0.00
TMR	ND	0.00	ND	ND	ND	ND	ND	0.00
AIT	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
NET	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
SAB	ND	ND	0.00	0.00	0.00	0.88	0.00	0.00
BAD	ND	ND	ND	ND	ND	ND	ND	ND
NAT	ND	ND	ND	ND	ND	ND	ND	0.00
SUB	ND	ND	ND	ND	ND	ND	ND	ND
BE 99								
INDUSTRY	0.14	0.14	0.12	0.36	0.14	0.00	0.00	0.00
AIT	0.00	0.00	0.00	ND	ND	ND	ND	ND
ARA	ND	ND	ND	ND	ND	ND	ND	ND
BID	0.00	0.00	0.00	ND	ND	ND	ND	ND
ZMT	ND	ND	ND	ND	ND	ND	ND	ND
CAL	ND	ND	ND	ND	ND	ND	ND	ND
TIM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ARE	ND	ND	ND	ND	ND	ND	ND	ND
GEP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
SUB	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
YHS	0.00	ND	0.00	1.41	0.00	ND	ND	ND
BDM	ND	ND	ND	ND	ND	ND	ND	ND
EMT	ND	ND	ND	ND	ND	ND	ND	ND
CBP	ND	ND	ND	ND	ND	ND	ND	ND
ARO	0.00	0.00	ND	1.22	0.00	ND	ND	0.00
OSA	0.00	0.00	0.00	ND	0.00	0.00	ND	0.00
OTR	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SIB	0.00	0.92	1.03	1.04	1.21	0.00	0.00	0.00
TEM	0.00	0.00	0.00	ND	0.00	0.00	0.00	ND
JJJ	ND	ND	ND	ND	ND	ND	ND	ND
TUM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CUL	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
NET	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
NAT	ND	ND	ND	0.00	0.00	0.00	0.00	0.00
ESU	ND	ND	ND	ND	ND	ND	ND	0.00
BAD	ND	ND	ND	ND	ND	ND	ND	ND
ISA	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
DHC6								
INDUSTRY	0.10	0.22	0.10	0.25	0.25	0.00	0.00	0.00
ARU	ND	ND	ND	ND	ND	ND	ND	ND
SLP	0.48	0.41	0.00	0.81	0.40	0.00	0.00	0.00
CPU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CBA	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00
LMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOB	ND	ND	ND	ND	ND	ND	ND	ND
PMT	ND	ND	ND	ND	ND	ND	ND	ND
FES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IET	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
NUT	ND	ND	ND	ND	ND	ND	ND	ND
WGR	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00
ASI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GUP	ND	ND	ND	ND	ND	ND	ND	ND
AET	ND	ND	5.95	0.00	7.96	0.00	0.00	0.00
KNY	0.00	ND	0.00	0.00	0.00	0.00	0.00	0.00
GOP	0.00	0.00	ND	1.02	0.00	0.00	0.00	0.00
QMT	ND	ND	ND	ND	ND	ND	ND	ND
NIT	0.00	0.00	0.00	ND	0.00	ND	0.00	ND
FIS	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
BMT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GIP	0.00	0.00	0.00	0.00	0.00	0.00	ND	ND
FAS	0.00	0.00	0.00	ND	0.00	ND	0.00	0.00
CBE	ND	ND	ND	ND	ND	ND	ND	0.00
DHC7								
INDUSTRY	0.45	0.43	0.46	0.62	0.37	0.24	0.55	0.34
MAB	ND	ND	ND	ND	ND	ND	0.67	0.30
RCW	0.44	0.00	0.67	1.91	0.72	0.49	2.54	0.73
CIL	ND	ND	ND	ND	ND	ND	ND	ND
GUP	0.58	0.65	0.24	0.00	0.66	0.31	0.00	0.28
AET	ND	ND	0.00	0.00	0.00	0.00	0.00	0.00
GOP	ND	ND	ND	ND	ND	ND	ND	ND
PVK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
URW	0.67	0.44	0.93	0.50	0.22	0.00	0.00	0.00
FUS	0.10	0.37	0.18	0.20	0.10	0.10	0.00	0.22
ARI	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BAD	ND	ND	ND	ND	ND	ND	ND	ND
EMB110								
INDUSTRY	0.20	0.21	0.22	0.37	0.00	0.18	0.21	0.00
MAB	ND	ND	ND	ND	ND	ND	0.00	0.00
SEB	ND	ND	ND	ND	ND	ND	ND	ND
BED	1.70	1.86	1.74	0.00	0.00	0.00	0.00	ND
TUC	0.00	0.00	0.00	0.25	0.00	0.15	0.32	0.00
CAL	ND	ND	ND	ND	ND	ND	ND	ND
GEP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
QXC	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
ASO	ND	ND	ND	ND	ND	ND	ND	ND
NOT	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
RMT	0.00	0.00	ND	ND	ND	ND	ND	ND
VER	ND	ND	ND	ND	ND	ND	ND	ND
CBI	ND	ND	ND	ND	ND	ND	ND	ND
SH SD330								
INDUSTRY	0.19	0.23	0.17	0.26	0.06	0.19	0.28	0.20
ARO	0.00	0.00	ND	ND	ND	ND	ND	ND
URW	ND	ND	ND	ND	ND	ND	ND	ND
IMX	0.00	0.33	0.29	0.00	0.30	0.00	0.00	0.71
BOD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YTZ	0.00	0.00	0.00	ND	0.00	ND	0.23	0.00
USE	0.00	ND	ND	0.00	0.00	2.03	ND	ND
CJU	0.00	0.00	0.00	0.75	0.00	0.00	ND	0.00
MAB	ND	ND	ND	ND	ND	ND	ND	ND
COL	1.38	1.35	0.00	0.72	0.00	0.00	0.00	0.00
EKV	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00
LOZ	0.19	0.09	0.09	0.19	0.00	0.19	0.29	0.09
TUC	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.00
ISA	0.00	ND	ND	ND	ND	ND	ND	ND
PQB	ND	ND	ND	ND	ND	ND	ND	ND
BUD	ND	ND	ND	ND	ND	ND	ND	ND
	Feb-90	Mar-90	Apr-90	May-90	Jun-90	Jul-90	Aug-90	Sep-90
BE 1900								
INDUSTRY	0.21	0.13	0.18	0.23	0.28	0.18	0.24	0.18
GAP	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOM	ND	ND	ND	ND	ND	ND	ND	ND
TIM	0.00	ND	0.30	0.00	0.00	0.00	0.00	0.00
YHS	0.00	0.00	0.00	0.13	0.12	0.00	0.00	ND
GLW	0.27	0.48	ND	ND	ND	ND	ND	ND
CJU	0.00	0.31	0.59	ND	0.00	0.00	0.21	0.45
OTR	0.00	0.00	ND	0.78	0.53	ND	0.00	0.67
NPA	0.66	0.00	0.57	0.27	ND	0.56	0.55	ND
PQB	0.00	ND	0.00	0.00	0.32	0.31	0.00	0.00
EKV	0.18	0.00	0.00	0.00	0.19	0.43	0.42	0.00
OSA	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
CEL	ND	ND	ND	ND	ND	ND	ND	ND
TAM	ND	ND	ND	ND	ND	ND	ND	ND
TMR	ND	ND	ND	ND	0.00	0.00	0.00	0.00
AIT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NET	ND	0.00	0.00	0.00	0.00	0.00	0.00	ND
SAB	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00
BAD	ND	ND	0.00	1.27	1.01	0.19	0.48	0.19
NAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SUB	ND	ND	ND	ND	ND	ND	ND	0.00
BE 99								
INDUSTRY	0.00	0.00	0.00	0.42	0.34	0.00	0.16	0.00
AIT	ND	ND	ND	ND	ND	ND	ND	ND
ARA	ND	ND	ND	ND	ND	ND	ND	ND
BID	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
ZMT	ND	ND	ND	ND	ND	ND	ND	ND
CAL	ND	ND	ND	ND	ND	ND	ND	ND
TIM	0.00	ND	0.00	0.00	0.00	0.00	0.00	ND
ARE	ND	ND	ND	ND	ND	ND	ND	ND
GEP	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
SUB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YHS	ND	ND	ND	ND	ND	ND	ND	ND
BDM	ND	ND	ND	ND	ND	ND	ND	ND
EMT	ND	ND	ND	ND	ND	ND	ND	ND
CBP	ND	ND	ND	ND	ND	ND	ND	ND
ARO	0.00	0.00	0.00	0.00	ND	0.00	1.73	0.00
OSA	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00
OTR	0.00	0.00	ND	0.57	0.48	ND	0.00	0.00
SIB	0.00	ND	ND	ND	ND	ND	ND	ND
TEM	ND	0.00	0.00	ND	ND	ND	ND	0.00
JJJ	ND	ND	ND	ND	ND	ND	ND	ND
TUM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CUL	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
NET	ND	0.00	0.00	0.00	0.00	0.00	0.00	ND
NAT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ESU	0.00	ND	0.00	0.00	0.00	0.00	ND	ND
BAD	ND	ND	ND	ND	ND	ND	0.00	0.00
ISA	ND	ND	ND	ND	ND	ND	0.00	ND
DHC6								
INDUSTRY	0.14	0.10	0.24	0.24	0.00	0.17	0.21	0.31
ARU	ND	ND	ND	ND	ND	ND	ND	ND
SLP	0.00	0.00	0.48	0.40	0.00	ND	0.95	1.09
CPU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOD	0.00	1.00	0.00	0.00	0.00	1.44	0.00	1.57
CBA	0.00	0.00	ND	0.00	0.00	0.25	0.25	ND
LMT	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOB	ND	ND	ND	ND	ND	ND	ND	ND
PMT	ND	ND	ND	ND	ND	ND	ND	ND
FES	0.00	0.00	0.00	0.00	ND	ND	ND	ND
IET	ND	0.00	0.00	0.00	ND	0.00	0.00	0.00
NUT	ND	ND	ND	ND	ND	ND	ND	ND
WGR	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00
ASI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GUP	ND	ND	ND	ND	ND	ND	ND	ND
AET	0.00	0.00	4.63	0.00	0.00	0.00	0.00	ND
KNY	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
GOP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
QMT	ND	ND	ND	ND	ND	ND	ND	ND
NIT	ND	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FIS	0.00	ND	ND	0.00	ND	ND	ND	ND
BMT	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
GIP	0.00	0.00	0.00	ND	0.00	0.00	ND	ND
FAS	0.00	ND	ND	0.00	0.00	0.00	0.00	ND
CBE	0.00	0.00	ND	0.00	0.00	0.00	0.00	0.00

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)								
DHC7								
INDUSTRY	0.43	0.27	0.30	0.06	0.41	0.53	0.37	0.32
MAB	0.00	1.20	0.58	0.00	1.19	0.59	0.00	0.00
RCW	0.55	0.30	0.89	0.30	0.62	1.16	1.14	0.00
CIL	ND	ND	ND	ND	ND	ND	ND	ND
GUP	0.59	0.26	ND	ND	ND	ND	ND	ND
AET	0.00	0.00	0.00	0.00	0.00	0.00	0.00	ND
GOP	ND	ND	ND	ND	ND	ND	ND	ND
PVK	0.00	0.00	0.00	0.00	0.00	ND	0.00	0.00
URW	0.84	0.26	0.00	0.00	0.00	ND	0.00	ND
FUS	0.13	0.00	0.13	0.00	0.00	0.00	0.22	0.33
ARI	0.00	0.00	0.00	0.00	0.31	0.33	0.00	0.00
BAD	ND	ND	0.00	0.00	0.91	0.78	0.49	0.48
EMB110								
INDUSTRY	0.00	0.28	0.00	0.65	0.30	0.30	0.46	0.24
MAB	0.00	0.36	0.00	0.54	0.18	0.18	0.70	0.37
SEB	ND	ND	ND	ND	ND	ND	ND	ND
BED	ND	ND	ND	ND	ND	0.00	ND	ND
TUC	0.00	0.14	0.00	0.00	0.15	0.32	0.17	0.00
CAL	ND	ND	ND	ND	ND	ND	ND	ND
GEP	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
QXC	0.00	0.00	0.00	0.30	0.29	0.00	0.00	0.00
ASO	ND	ND	ND	ND	ND	ND	ND	ND
NOT	ND	ND	ND	ND	ND	ND	ND	ND
RMT	ND	ND	ND	ND	ND	ND	ND	ND
VER	ND	ND	ND	ND	ND	ND	ND	ND
CBI	ND	ND	ND	ND	0.00	0.00	0.00	0.00
SH SD330								
INDUSTRY	0.27	0.20	0.27	0.15	0.32	0.00	0.19	0.22
ARO	ND	ND	ND	ND	ND	ND	ND	ND
URW	ND	ND	ND	ND	ND	ND	ND	ND
IMX	0.26	0.22	0.58	0.16	0.19	0.00	0.00	0.00
BOD	0.00	0.00	0.00	0.00	1.04	0.00	0.00	0.00
YTZ	ND	0.38	ND	ND	ND	ND	0.00	ND
USE	ND	ND	ND	ND	ND	0.00	0.00	ND
CJU	0.00	0.00	0.00	ND	0.00	0.00	0.00	0.00
MAB	ND	ND	ND	ND	ND	ND	ND	ND
COL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EKV	0.51	0.23	0.00	0.00	0.00	0.00	0.00	0.00
LOZ	0.11	0.09	0.19	0.09	0.29	0.00	0.34	0.18
TUC	0.00	0.00	0.00	ND	0.00	0.00	0.90	0.00
ISA	ND	ND	ND	ND	ND	ND	0.00	2.83
PQB	ND	ND	ND	ND	ND	ND	ND	ND
BUD	ND	ND	ND	ND	ND	ND	ND	ND

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)							
	Oct-90	Nov-90	Dec-90	Jan-91			
BE 1900							
INDUSTRY	0.07	0.32	0.13	0.04			
GAP	0.00	0.00	0.00	0.00			
TOM	ND	ND	ND	ND			
TIM	0.00	0.00	0.00	0.00			
YHS	0.00	0.00	0.00	0.00			
GLW	ND	ND	ND	ND			
CJU	0.00	0.00	0.60	0.00			
OTR	ND	1.86	0.82	0.00			
NPA	0.36	0.00	0.45	0.00			
PQB	0.00	0.31	0.24	0.00			
EKV	0.00	0.00	0.00	0.00			
OSA	0.00	2.58	ND	ND			
CEL	ND	ND	ND	ND			
TAM	ND	ND	ND	ND			
TMR	0.00	ND	ND	0.00			
AIT	0.00	0.00	0.00	0.00			
NET	0.00	0.00	0.00	0.00			
SAB	0.00	0.00	0.00	0.00			
BAD	0.20	0.93	0.00	0.19			
NAT	0.00	0.00	0.00	0.00			
SUB	0.00	4.20	0.00	0.00			
BE 99							
INDUSTRY	0.00	0.26	0.00	0.00			
AIT	ND	ND	ND	ND			
ARA	ND	ND	ND	ND			
BID	ND	ND	ND	ND			
ZMT	ND	ND	ND	ND			
CAL	ND	ND	ND	ND			
TIM	0.00	0.00	0.00	0.00			
ARE	ND	ND	ND	ND			
GEP	ND	0.00	0.00	0.00			
SUB	0.00	0.00	0.00	0.00			
YHS	ND	ND	ND	ND			
BDM	ND	ND	ND	ND			
EMT	ND	ND	ND	ND			
CBP	ND	ND	ND	ND			
ARO	0.00	0.00	0.00	ND			
OSA	ND	0.00	ND	ND			
OTR	ND	0.64	0.00	0.00			
SIB	ND	ND	ND	ND			
TEM	ND	1.00	0.00	0.00			
JJJ	ND	ND	ND	ND			
TUM	0.00	0.00	0.00	0.00			
CUL	0.00	ND	ND	ND			
NET	0.00	0.00	0.00	0.00			
NAT	0.00	0.00	0.00	0.00			
ESU	0.00	0.00	0.00	0.00			
BAD	0.00	0.00	0.00	0.00			
ISA	ND	0.00	ND	ND			

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)							
DHC6							
INDUSTRY	0.18	0.30	0.00	0.26			
ARU	ND	ND	ND	ND			
SLP	1.06	1.18	0.00	0.00			
CPU	0.00	0.00	0.00	0.00			
BOD	ND	0.00	0.00	0.00			
CBA	0.00	0.00	ND	0.00			
LMT	0.00	0.00	0.00	0.00			
SOB	ND	ND	ND	ND			
PMT	ND	ND	ND	ND			
FES	ND	ND	ND	ND			
IET	0.00	0.00	0.00	0.00			
NUT	ND	ND	ND	ND			
WGR	0.00	0.27	0.00	0.64			
ASI	0.00	0.00	0.00	0.00			
GUP	ND	ND	ND	ND			
AET	0.00	0.00	0.00	0.00			
KNY	0.00	0.00	0.00	0.00			
GOP	0.00	ND	ND	ND			
QMT	ND	ND	ND	ND			
NIT	0.00	0.00	0.00	0.00			
FIS	0.00	ND	0.00	ND			
BMT	0.00	0.00	0.00	0.00			
GIP	ND	ND	ND	ND			
FAS	0.00	ND	ND	ND			
CBE	0.00	0.00	0.00	0.00			
DHC7							
INDUSTRY	0.46	0.43	0.53	0.20			
MAB	0.00	0.00	0.85	0.00			
RCW	1.35	0.97	0.66	0.37			
CIL	ND	ND	ND	ND			
GUP	ND	ND	ND	ND			
AET	0.00	0.00	0.00	0.00			
GOP	ND	ND	ND	ND			
PVK	0.00	0.00	0.00	0.00			
URW	ND	0.26	0.26	0.24			
FUS	0.10	0.00	0.00	0.00			
ARI	0.34	0.68	0.33	0.00			
BAD	0.63	0.70	0.93	0.00			
EMB110							
INDUSTRY	0.14	0.00	0.20	0.00			
MAB	0.17	0.00	0.20	0.00			
SEB	ND	ND	ND	ND			
BED	ND	ND	ND	ND			
TUC	0.00	0.00	0.00	0.00			
CAL	ND	ND	ND	ND			
GEP	ND	0.00	0.00	0.00			
QXC	0.00	0.00	0.00	0.00			
ASO	ND	ND	ND	ND			
NOT	ND	ND	ND	ND			

PT6 MONTHLY PERFORMANCE ENGINE REMOVALS (CONTINUED)							
RMT	ND	ND	ND	ND			
VER	ND	ND	ND	ND			
CBI	0.00	0.00	0.00	0.00			
SH SD330							
INDUSTRY	0.22	0.23	0.30	0.45			
ARO	ND	ND	ND	ND			
URW	ND	ND	ND	ND			
IMX	0.00	0.00	0.00	0.13			
BOD	ND	0.00	0.00	0.56			
YTZ	ND	ND	ND	ND			
USE	0.00	3.11	0.00	0.00			
CJU	0.00	0.00	0.00	0.00			
MAB	ND	ND	ND	ND			
COL	0.00	ND	ND	ND			
EKV	0.00	0.00	0.35	0.30			
LOZ	0.35	0.36	0.39	0.54			
TUC	0.00	0.00	0.00	0.00			
ISA	ND	0.00	ND	ND			
PQB	ND	ND	ND	ND			
BUD	ND	ND	ND	0.00			

APPENDIX B - AIRLINE MACRO SCANS

**APPENDIX B
AIRLINE MACRO SCANS**

B-747/JT9D AIRLINE MACRO SCAN						
AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
ABC	34	35	54	2	31	7
QOO	21	17	53	3	24	11
BKB	40	32	59	1	47	4
DEF	21	18	22	10	61	2
LWZ	17	35	23	9	29	8
JKL	6	30	40	5	73	1
DAR	4	34	53	4	24	12
CTA	8	34	32	7	53	3
AAA	1	14	36	6	21	13
ILT	2	24	29	8	29	9
DDA	2	35	20	11	37	6
RAB	31	35	11	12	37	5
NNN	3	16	13	13	25	10

B-767/JT9D AIRLINE MACRO SCAN						
AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
RAB	19	35	9	2	26	1
LWZ	11	35	11	1	6	2

DC-10/JT9D AIRLINE MACRO SCAN						
AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
BKB	20	32	3	1	0	2
NZT	1	32	0	2	3	1

A-300/CF6 AIRLINE MACRO SCAN						
AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
ABC	12	35	17	1	46	1
DDA	20	33	15	2	21	3
XYZ	14	34	12	3	29	2
CTA	13	34	9	4	18	4

B-767/CF6 AIRLINE MACRO SCAN						
AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
FPC	30	33	12	1	24	1
SSS	6	16	6	2	13	3
DDA	45	35	3	3	9	2
GGA	7	16	0	4	0	4

DC-10/CF6 AIRLINE MACRO SCAN						
AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
DEF	24	36	39	1	33	4
DDA	59	35	31	3	31	5
TMR	6	35	20	5	51	1
RAB	55	35	37	2	17	7
CTA	15	34	24	4	41	3
PPP	1	7	14	6	14	8
XYZ	2	32	3	7	25	6
FPC	4	10	0	8	50	2

BE-1900/PT6 AIRLINE MACRO SCAN						
AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
OTR	10	25	28	2	36	3
PBQ	7	30	23	3	27	6
EKV	14	30	20	4	13	9
CJU	11	31	19	6	23	7
NPA	9	32	9	10	31	4
TOM	16	5	60	1	40	2
SUB	1	5	20	5	20	8
GAP	11	36	11	8	8	12
YHS	13	30	10	9	7	13
NAT	3	13	15	7	0	16
AIT	1	20	5	11	5	14
OSA	2	23	4	12	4	15
TIM	2	34	3	13	12	10
BAD	14	10	0	14	80	1
GUP	10	25	0	15	28	5
SAB	10	18	0	16	11	11
CEL	1	14	0	17	0	17
TAM	6	1	0	18	0	18
TMR	2	10	0	19	0	19
NET	5	16	0	20	0	20

**BE-99/PT6
AIRLINE MACRO SCAN**

AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
YHS	4	17	29	1	29	5
OTR	6	25	12	4	16	8
AIT	7	18	11	6	17	6
JJU	3	17	12	5	35	4
SIB	3	12	5	12	38	3
SUB	3	34	6	11	3	12
TIM	2	35	3	13	9	10
BAD	8	6	17	2	0	13
CAL	2	15	13	3	0	14
ARA	1	9	11	7	0	15
TUM	2	21	10	8	0	16
ESU	6	10	10	9	0	17
ARE	7	14	7	10	0	18
CBP	4	3	0	14	67	1
BID	3	2	0	15	50	2
EMT	5	12	0	16	17	7
ARO	3	27	0	17	15	9
TEM	5	16	0	18	6	11
ZMT	3	15	0	19	0	19
GEP	1	32	0	20	0	20
BDM	1	4	0	21	0	21
OSA	2	28	0	22	0	22
CUL	1	14	0	23	0	23
NET	4	16	0	24	0	24
NAT	5	17	0	25	0	25
ISA	2	2	0	26	0	26

**DHC-6/PT6
AIRLINE MACRO SCAN**

AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
WGR	7	36	17	1	25	2
KNY	13	34	15	2	3	10
SLP	7	28	7	3	50	1
GOP	5	29	7	4	24	3
CBA	11	33	6	6	18	4
AET	1	31	6	7	13	5
NIT	1	24	4	8	4	9
BOD	2	34	3	9	9	6
LMT	2	36	3	10	6	7
BMT	2	30	7	5	0	11
FAS	2	17	0	11	6	8
CPU	1	34	0	12	0	12
ASI	1	36	0	13	0	13
IET	3	33	0	14	0	14
FES	4	28	0	15	0	15
FIS	1	21	0	16	0	16
GIP	2	18	0	17	0	17
CHE	2	12	0	18	0	18
QMT	2	9	0	19	0	19
GUP	3	8	0	20	0	20
PMT	1	6	0	21	0	21
NUT	4	4	0	22	0	22
SOB	3	2	0	23	0	23
ARU	2	1	0	24	0	24

**DHC-7/PT6
AIRLINE MACRO SCAN**

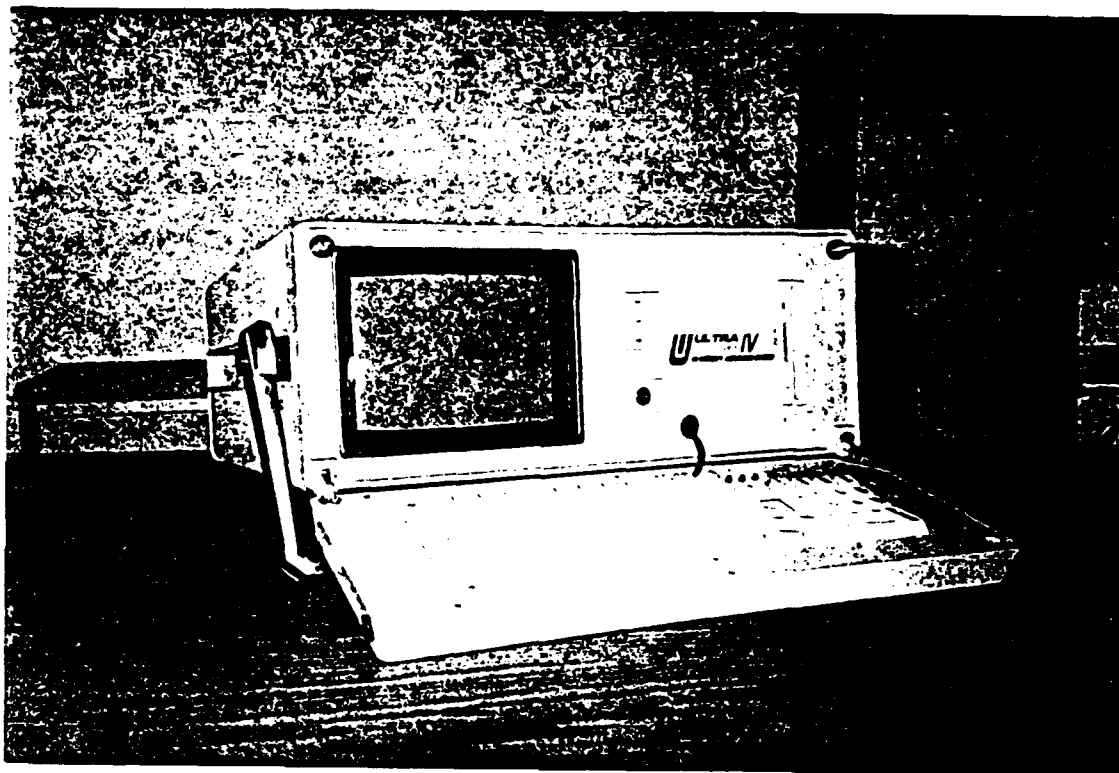
AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
RCW	8	36	22	3	92	1
MAB	4	30	23	2	57	3
GLW	5	24	17	4	21	5
URW	5	31	13	6	19	6
FUS	12	32	13	5	3	9
ARI	3	23	13	7	9	8
GOP	2	13	8	8	31	4
AET	3	31	3	9	13	7
PVK	1	36	6	10	3	10
CIL	10	3	67	1	0	11
BAD	5	10	0	11	70	2

EMB-110/PT6 AIRLINE MACRO SCAN						
AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
TUC	25	36	25	1	6	6
MAB	14	30	17	3	57	1
QXC	12	35	17	4	9	5
NOT	9	5	20	2	40	2
BED	5	22	9	5	23	3
RMT	2	18	6	6	0	7
VER	5	9	0	7	22	4
GEP	1	31	0	8	0	8
CAL	2	12	0	9	0	9
ASO	2	12	0	10	0	10
CBI	1	8	0	11	0	11
SEB	4	2	0	12	0	12

SH SD-330/PT6 AIRLINE MACRO SCAN						
AIRLINE	AVERAGE NUMBER AIRCRAFT	NUMBER MONTHS DATA	% IN-FLIGHT SHUTDOWNS EXCEEDANCES	RANK SHUTDOWNS	% ENGINE REMOVALS EXCEEDANCES	RANK ENGINE REMOVALS
LOZ	31	34	24	2	38	2
IMX	8	36	17	4	36	3
EKV	10	33	9	9	18	7
BOD	4	34	12	7	15	10
ISA	8	13	31	1	31	5
MAB	6	14	21	3	43	1
USE	6	22	14	5	18	8
URW	7	15	13	6	33	4
TUC	5	35	9	10	11	12
COL	6	33	6	11	18	9
CJU	6	33	6	12	12	11
PBQ	3	9	11	8	0	14
ARO	2	14	0	13	21	6
YTZ	9	16	0	14	6	13
BUD	1	1	0	15	0	15

APPENDIX C - UI-IV™ ULTRASONIC IMAGING SYSTEM SPECIFICATIONS

Ultra Image IV Portable Imaging System



Specifications:	
Ultrasonic Imaging Modules:	
Ultrasonic Programmable Receiver (UPR):	Single-channel digital ultrasonic signal acquisition with 4 independent signal gates for amplitude, time and A-scan signal capture.
Remote Pulser Preamp:	20 dB or 40 dB software selectable gain. 0-500 volt spike pulser
Single Channel Software Package:	Basic operating software for the RPP-1 and UPR.
B & C Scan Imaging Package:	B and C scan imaging for one to eight ultrasonic channels. Imaging software contains the Scan SETUP and Scan modules required to perform 2-D scanning operations.
Analysis Software:	Planar, 3-D displays, and Histogram for time of flight and Amplitude data.
Computer:	80386-DX Processor with Math Coprocessor and 4MB RAM
Monitor:	9.0" built in VGA Color CRT
Floppy Drives:	1.44MB, 3.5"
Hard disk Drive:	80MB 3.5" IDE
Dimensions:	17.5"W x 6.8"H x 17.1"D, weighing approximately 32 lbs. Fully Assembled

APPENDIX D - NDI PROCEDURE DESCRIPTION

APPENDIX D

NDI Procedure Descriptions

Ultrasonic Imaging Inspection of JT9D Outer Diffuser Casing Stiffener Rail by Computer Controlled Motorized Scanner:

1 Objective

Use of ultrasonic imaging methods to inspect JT9D outer diffuser casing stiffener rail by computer controlled motorized scanner.

2 Reference:

- 2.1 DOT/FAA/CT-91/10 Turbine Aircraft Engine Operational Trending and JT8D Static Component Reliability Study, March 1992, p. C-1.

3 Equipment and Materials

- 3.1 UI-IV™ - Ultrasonic Imaging System
- 3.2 Transducer - 5 MHz, Angle Beam, 52 Degrees, 3/8" Diameter
- 3.3 Transducer Cable - 25 feet
- 3.4 Power Cable
- 3.5 Couplant - Aluminum Tap Oil
- 3.6 Scanner - UII/SAIC computer controlled motorized scanner
- 3.7 Disk - 3.5", DS HD, 135 TPI, 1.44 MB
- 3.8 Notebook

4 Safety Precaution

All personnel performing the inspection shall wear safety goggles.

5 Equipment setup - UI-IV™

- 5.1 Turn power on - Manual selection will appear on UI-IV™
 - 5.2 Select Scan File - JT9D data
 - 5.3 Update Test Descriptions
 - 5.4 Select setup
 - 5.5 Select Robot, Ratio, X: 320, Y: 3400
 - 5.6 Select Teach, Place: for C - Scan,
 - 5.6.1 Index: Y-Resolution 1mm, Length: 20mm
 - 5.6.2 Scan: X-Resolution 1mm, Length: 200mm
 - 5.7 Select Edit
 - 5.7.1 Save File
 - 5.8 Select Copy, plot, file output name
 - 5.9 Select Scan - When the screen shows designated scanning areas, the system is ready to record data.
- ##### **6 Scanner Setup - Computer controlled motorized scanner**

- 6.1 Load the program disk in the motion controller processor; manual selections will appear on screen.
- 6.2 Use JOG command and arrow keys to move the transducer to any designated location as home position.
- 6.3 Enter scanning parameters, such as scanner speed and acceleration, length of scanning direction, increment directions, etc.
- 6.4 Press SCAN to start scan; the transducer will move from home position to scan along the X-direction with increment in the Y-direction. When the entire area is scanned, the scanner will return to the home position and stop automatically.
7. Press E on UI-IV™ system to save data.
8. Take notes on test as appropriate. At this point, scanning is complete.
9. Evaluation of results

If any defects are detected, areas of distinctive signal amplitude change will show on the image. If there is no defect in the inspected area, the image will show a uniform color over the entire inspected area.